REGIONAL STATE OF OCEAN AND COASTS 2021:

THE EAST ASIAN SEAS REGION

Blue economy: Where are we now? Where are we heading?

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VOLUME 1

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The East Asian Seas Region (Volume 1)

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Acronyms and Abbreviations

%	percent
3Rs	reduce, reuse, recycle
ACB	ASEAN Centre of Biodiversity
ACE	ASEAN Center of Energy
ADB	Asian Development Bank
APEC	Asia-Pacific Economic Cooperation
APSN	APEC Port Services Network
ASEAN	Association of Southeast Asian Nations
ATS	Arafura-Timor Seas
ATSEA	Arafura and Timor Seas Ecosystem Action
b/d	barrels per day
bbl	barrel (of crude oil)
BBNJ	biodiversity located in areas beyond national jurisdiction
BOBLME	Bay of Bengal Large Marine Ecosystem
BOD	biochemical oxygen demand
BOE	barrel of oil equivalent
C	carbon
C	Celsius
CABCOM-MOA	Cabinet Committee on Maritime and Ocean Affairs
CBD	Convention on Biological Diversity
CNOOC	China National Offshore Oil Corporation
CO_2	carbon dioxide
COD	chemical oxygen demand
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTCN	Climate Technology Centre and Network
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security
DDT	dichlorodiphenyltrichloroethane
DENR	Department of Environment and Natural Resources (Philippines)
DMCR	Department of Marine and Coastal Resources (Thailand)
DOE	Department of Energy (Philippines)
DPSIR	Drivers-Pressures-State-Impact-Response
DWT	deadweight tonnage
EAFM	ecosystem approach to fisheries management
EAS	East Asian Seas
EDB	Economic Development Board (Philippines)
EEE	Electrical and Electronic Equipment
EEPSEA	Economy and Environment Programme for Southeast Asia
EEZ	exclusive economic zone
EIB	European Investment Bank
ENSO	El Niño-Southern Oscillation
ESI	environment sensitivity index
EO	Executive Order
ESG	Environmental, Social and Governance
EST	environmentally sound technology
ETS	emissions trading system
EU	European Union
FAO	Food and Agriculture Organisation
FiT	Feed-in-tariff
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gases
GIWA	Global International Waters Assessment
GNI	gross national income
GoT	Gulf of Thailand
GPAS	Green Port Award System
GPI	green port index
GT	gross tonnage
GVA	gross value added
GW	gigawatt

ha	hectare
HCH	hexachlorocyclohexane
HCI	Human Capital Index
HDI	Human Development Index
HNS	hazardous and noxious substances
I-O	input-output
ICM	integrated coastal management
ICRI	International Coral Reef Initiative
IDR	Indonesian rupiah
IEA	International Energy Agency
IEC	Information, education, and communication
ILO	International Labour Organisation
IMO	International Maritime Organization
IMS	Integrated Management System
IOD	Indian Ocean Dipole
IOM	integrated ocean management
IoT	internet of things
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISLME	Indonesia Sea Large Marine Ecosystem
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
IUU	Illegal, unreported, and unregulated
IWMF	Integrated Waste Management Facility
JPDA	Joint Petroleum Development Area
kg	kilogram
km	kilometer
km^2	square kilometer
KIOST	Korea Institute of Ocean Science and Technology
KMI	Korean Maritime Institute
KOICA	Korea International Cooperation Agency
KRW	Korean won
LGU	local government unit
LME	large marine ecosystems
LNG	liquefied natural gas
LPI	Logistics Performance Index
LSCI	Liner Shipping Connectivity Index
m	meter
m^2	square meter
m^3	cubic meter
MARPOL	International Convention for the Prevention of Pollution from Ships
MBOPD	million barrels of oil per day
MCS	monitoring, control, and surveillance
MEA	multilateral environmental agreements
Mg	megagram (= 1 tonne)
MICE	Meetings, Incentives, Conventions and Exhibitions
mm	millimeter
MMAF	Ministry of Marine Affairs and Fisheries (Indonesia)
MMSCFD	million standard cubic feet per day
MOE	Ministry of Environment
MOF	Ministry of Oceans and Fisheries (RO Korea)
MOEF	Ministry of Environment and Forestry (Indonesia)
MOF	Ministry of Finance (Indonesia)
MOMAF	Ministry of Marine Affairs and Fisheries
MOTIE	Ministry of Trade, Industry and Energy (RO Korea)
MoU	Memorandum of Understanding
MPA	marine protected area
MPA	Maritime and Port Authority of Singapore
MRE	marine renewable energy
MRF	Materials Recovery Facility
MSP	marine spatial plan
MSW	municipal solid waste
MW	megawatt
NARRDS	National Aquatic Resources Research and Development System
NCWS	National Coast Watch System

NDC	Nationally Determined Contributions
NDE	national designated entity
NEA	National Environment Agency (Singapore)
NEDO	New Energy and Industrial Technology Development (Japan)
NGO	nongovernment organization
NOAA	National Oceanic and Atmospheric Administration
NOWPAP	Northwest Pacific Action Plan
NO_x	nitrogen oxides
NPOA	National Plan of Action
NSOC	National State of Ocean and Coasts
NTU	Nanyang Technological University
ODA	Official Development Assistance
ODF	Official Development Finance
OECD	Organisation for Economic Co-operation and Development
OECM	Other effective area-based conservation measures
OFI	Ocean Financing Initiative
OHI	ocean health index
OPEC	Organization of the Petroleum Exporting Countries
OPRC	International Convention on Oil Pollution Preparedness Response and Cooperation
OTEC	ocean thermal energy conversion
PCB	polychlorinated biphenyls
PCB	printed circuit boards
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PHP	Philippine peso
PM	particulate matter
PNOC	Philippine National Oil Company
POP	persistent organic pollutant
PPA	Philippine Ports Authority
PPP	public-private partnerships
PPP	purchasing power parity
ppt	parts per thousand
PROPER	Program for Pollution control, Evaluation, and Rating
PSA	Philippine Statistics Authority
PSHEMS	Port Safety, Health and Environmental Management Systems
PSP	Poznan Strategic Program
PTS	persistent toxic substances
R&D	research and development
RE	renewable energy
REC	Renewable Energy Certificate
REDD+	Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks
REPS	Renewable Energy Portfolio Standard
RFMO	Regional Fisheries Management Organizations
RO	reverse osmosis
RPOA	Regional Plan of Action
RPS	Renewable Portfolio Standard
RSAP	Regional Strategic Action Programme
RSOC	Regional State of Ocean and Coasts
SBR	Shipbuilding and repair
SDGs	Sustainable Development Goals
SDS-SEA	Sustainable Development Strategy for the Seas of East Asia
SEEA	System of Environmental-Economic Accounting
SHE	safety, health and environmental
SNA	System of National Accounts
SOA	State Oceanic Administration of China
SOC	State of Ocean and Coasts
SOC	State of Coasts
SO_x	Sulphur oxides
SSME	Sulu-Sulawesi Marine Ecoregion
SST	sea surface temperature
SWM	solid waste management

TA	technical assistance
TBT	tributyl tin
TCF	trillion cubic feet
tCO_2e	tonne CO_2 equivalent
TDA	Transboundary Diagnostic Analysis
TDA-SAP	Transboundary Diagnostic Analysis - Strategic Action Programme
TEC	Technology Executive Committee
TEEB	The Economics of Ecosystems and Biodiversity
TEI	Thailand Environment Institute
TEU	twenty-foot equivalent unit
Tg	teragram (= 1,000,000 tonne)
TMFA	Tunas Mekar Fisher Association
TNA	technology needs assessment
TWAP	Transboundary Waters Assessment Project
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	United Nations Conference on Sustainable Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USD	United States dollar
USGS	United States Geological Survey
VND	Vietnamese dong
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WEEE	electrical and electronic equipment waste
WOA	World Ocean Assessment
WTE	waste to energy
WTP	willingness to pay
WTTC	World Travel & Tourism Council
WWF	World Wide Fund for Nature; World Wildlife Fund (US and Canada)
WWTP	wastewater treatment plant
YSLME	Yellow Sea Large Marine Ecosystem

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- Cambodia: Ministry of Environment (MOE)
- China: Ministry of Natural Resources (MNR)
- Indonesia: Ministry of Environment and Forestry (MOEF)
- Malaysia: Maritime Institute of Malaysia (MIMA)
- Philippines: Department of Environment and Natural Resources (DENR)
- RO Korea: Ministry of Oceans and Fisheries (MOF)
- Singapore: National Parks Board
- Thailand: Department of Marine and Coastal Resources (DMCR)
- Timor-Leste: Ministry of Agriculture and Fisheries (MAF)
- Viet Nam: Viet Nam Administration for Seas and Islands (VASI) and Ministry of Natural Resources and Environment (MONRE)

The various members of the Technical Working Groups made the NSOC reports possible. The RSOC Report consolidated the information from these NSOC reports. The regional agencies, Non-Country Partners of PEMSEA, Integrated Coastal Management (ICM) sites, members of PEMSEA Network of Learning Centers (PNLC), and other development partners also provided much support to the development of this report, including data and studies. In particular, we would like to thank the following:

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- Capturing Coral Reef and Related Ecosystem Services Project (CCRES)
- GIZ Sulu-Sulawesi Marine Ecoregion (SSME)
- Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO) Regional Office for the Western Pacific (WESTPAC)
- Korean Maritime Institute
- Mangroves for the Future (MFF) - International Union for Conservation of Nature (IUCN) Asia Regional Office
- Philippine Statistics Agency
- Thailand Research Fund
- Western and Central Pacific Fisheries Commission (WCPFC)
- WorldFish (Malaysia, Philippines, and Timor-Leste)
- Yellow Sea Large Marine Ecosystem (YSLME)

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- Organisation for Economic Co-operation and Development (OECD)
- United Nations Environment Programme (UNEP)
- United Nations Economic and Social Commission for Asia and Pacific (UNESCAP)
- IOC-WESTPAC

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Bai Tu Long Bay, Vietnam. *(Photo from VASI)*

Beach dining in Bali, Indonesia. *(Photo by M.Ebarvia)*

PART 1

RETHINKING OUR WEALTH: THE SEAS, PEOPLE, AND ECONOMIES

1 Introduction

"You cannot tackle hunger, disease, and poverty unless you can also provide people with a healthy ecosystem in which their economies can grow."

- **Gro Harlem Brundtland**

The East Asian Seas (EAS) region is a center of economic growth. Countries of the EAS region accounted for 63 percent of the world's total fisheries and aquaculture production in 2015. In 2018, the region contributed 74 percent of global aquaculture of fish, mollusks, and crustaceans, 99.5 percent of world's aquaculture production of seaweeds, and around 37 percent of the world's capture fisheries. The EAS Region attracts 26 percent of the world's tourists. Moreover, the region's seas serve as an important conduit of world trade, of which 90 percent is done through shipping (OECD 2019a). The second and third largest economies (China and Japan, respectively) are in this region. It is also home to the combined economies of the Association of Southeast Asian Nations (ASEAN), which represent the world's 5th largest economy and the 3rd largest global market with more than 630 million people. Moreover, the EAS region is known as the center of marine biodiversity globally. It is home to 31 percent of the world's mangroves and a third of the world's coral reefs and seagrass beds. There are also tidal flats, salt marshes, and seamounts. These blue habitats provide an extensive range of natural assets and resources – natural capital from which humans derive a wide variety of ecosystem services that make life possible and upon which human activities rely on.

The EAS region, however, faces an urgent need to clean up its seas, coasts and waterways, and conserve its ecosystems and biodiversity, while addressing the challenges of poverty alleviation, food, water and energy security, and climate change. The blue economy advocates innovative governance and an alternative economic growth strategy, in line with the Sustainable Development Goals (SDGs) and other multilateral environmental agreements (MEAs). Despite being a most pressing issue, sustainable coasts and oceans are among the least discussed. Nevertheless, this serious state of affairs offers an opportunity for communities, Governments, businesses, nongovernment organizations (NGOs), scientists, and development agencies to get involved and collaborate to conserve and harness sustainably the ocean wealth for inclusive prosperity, wellbeing, security and resilience.

1.1 Objectives of the SOC

In November 2015, Ministers and Senior Government Officials from 11 PEMSEA Partner Countries signed the **Da Nang Compact**, thereby adopting the *Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) 2015* and four post-2015 Strategic Targets. The four Targets of the

Da Nang Compact are designed to serve as indicators of country progress in implementing the *SDS-SEA 2015* over the next 5 years. Target 2 of the four strategic time-bound targets refers to a mechanism for monitoring and reporting progress for SDS-SEA implementation, specifically identifying the following milestone:

TARGET 2: *By 2018, a regional State of Oceans and Coasts reporting system to monitor progress, impacts and benefits, and to continually improve planning and management of SDS-SEA implementation.*

In addition to monitoring the progress in the implementation of the SDS-SEA, the State of Ocean and Coasts (SOC) report aims to:

- provide a mechanism to monitor ocean economic activities and ecosystem services, ocean health, policies and governance mechanisms, and show the impacts of directly or indirectly implementing the SDS-SEA.
- highlight the enormous economic potential, investment opportunities, and the socioeconomic and environmental benefits of transforming to blue economy.
- point out the development needs, and response requirements to address the growing natural and anthropogenic pressures imposed on the coastal and marine environment and threats from climate change.

1.2 Rationale

One of the most important but little noticed change over the past decades is how our perspective on the world's oceans has changed. Oceans were first considered vast and limitless. Following centuries of exploration, oceans became areas for nuclear testing, dumping of wastes, and exploitation for food, minerals, oil and gas, and other resources. Given the current challenges, the studies on the state of the marine environment have become more significant. There is now increasing recognition that oceans are finite, with fragile ecosystems and biodiversity under pressure from human activities, and climate and environmental changes. Yet, the benefits derived from the oceans as well as the environmental and societal impacts and costs of over-exploitation, pollution, and years of neglect have not been fully quantified.

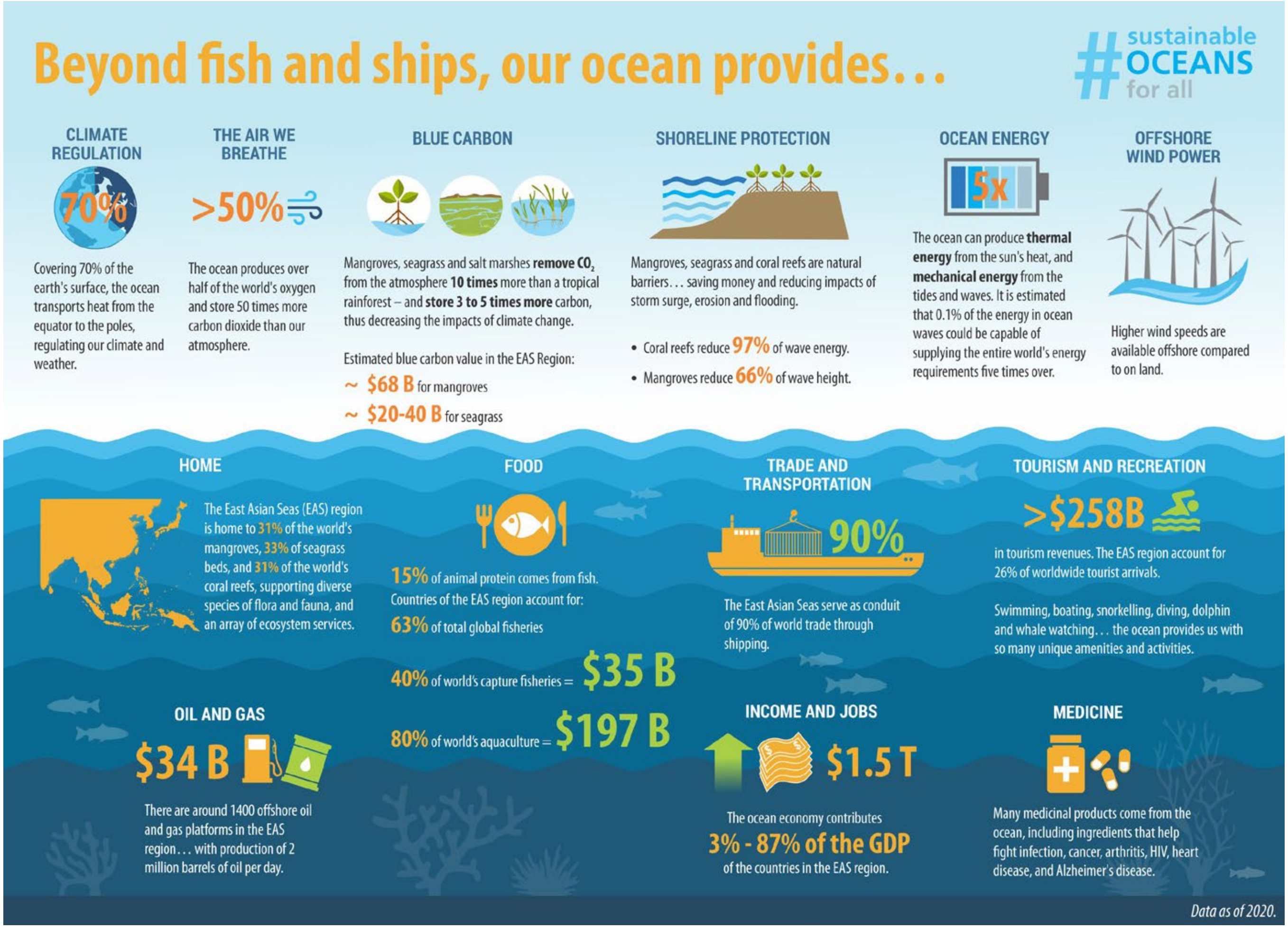
Moreover, ocean-based economies have entered a historic period of structural transition, where the importance of *established* sectors (e.g., capture fisheries, offshore oil and gas) are declining relative to *emerging* sectors (e.g., mariculture, marine renewable energy, biotechnology, desalination, submarine communications, etc.) as pointed out by the Organisation for Economic Co-operation and Development (OECD 2016). All of these changes are taking place in a changing climate that is altering the physical properties of oceans that may dramatically shift the foundations of ocean and coastal economies. Though changes, such as sea-level rise and ocean acidification, are becoming known, uncertainty remains about the extent and timing with which these ocean changes will affect coastal resources and communities.

It has therefore become critical to understand that each of our uses of oceans have impacts and involves real or potential tradeoffs with other uses. This means we need a much better and more detailed understanding of the economic values of oceans and coastal and marine resources, impact of human activities on those values, and the state of ocean health, which could affect future benefits and services. Although issues on data availability and valuation methods pose constraints in developing the integrated ocean environmental-economic accounting system, efforts on estimating the value of ocean activities and ecosystem services should be supported and continued. This would improve understanding of the role of the oceans in the economy, environment, climate, and human welfare. Moreover, knowing the state of the oceans, integrity of ecosystems, and the structure of the ocean economy will be critical to see how externalities and issues, such as storms, biodiversity loss and environmental changes may impact sustainable development and wellbeing. The assessment of the ocean economy and ocean health supports sound policy- and decision-making aimed at protecting the coastal and marine environment, which underpins sustainable blue economy.

This Regional SOC report finds its rationale against a backdrop of these on-going changes in ocean activities as pressures from urbanization, pollution, over-exploitation, and climate change necessitate more careful management. This report also shows the ongoing transformation of ocean economic activities, and potential investment and employment opportunities, indicating that prosperity with inclusion and resiliency is possible.

Using the key themes on blue economy as discussed at the Rio+20 United Nations Conference on Sustainable Development (UNCSD 2012), and SDG 14 (Life Below Water), the SOC report focuses on the assessment of the following: (a) value of the ocean, including the oceanic natural capital and ecosystem services; (b) blue economy showing oceans as good business, including contribution to the economy, jobs and livelihood as well as innovative and sustainable ocean economic activities, and emerging industries; (c) state of ocean health; (d) measures on pollution management, restoration and protection of habitats and biodiversity, and climate action to ensure healthy and resilient oceans and people; and (e) ocean governance that supports blue economy development.

Figure 1.1: Ocean Economy and Ecosystem Services in the EAS Region (as of 2020).



1.3 What is Blue Economy?

The blue economy does not promote any type of economic growth, rather it subscribes to the principle of sustainable development. A well quoted definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".[1] It is also commonly accepted that sustainable development involves three pillars—society, environment, and economy—with this tripartite description often presented in the form of three overlapping circles with sustainability being the overlapping centre (**Figure 1.2**). Sustainability is a paradigm for thinking about the future in which environmental, societal, cultural, and economic considerations are intertwined and balanced in the pursuit of an improved quality of life.

[1] UN World Commission on Environment and Development (UNCED) 1987, p.41.

Figure 1.2: Sustainable Development and Its Three Pilars.

Within this context, the term "**blue economy**" has entered into the vocabulary of economic development in all parts of the world. But the meaning of "blue economy" is still evolving, with some emphasizing the possibilities of new ocean-based industries, such as ocean energy, biopharmaceuticals, deep sea mining, desalination, marine surveillance, while others emphasizing the need to transform both the established ocean economic sector and the emerging ocean industries into a more sustainable and inclusive economy, one that conserves the oceanic natural capital and provides opportunities across society.

The blue economy subscribes to the definition of sustainable development provided by FAO: *"Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable"*.[2]

Blue economy is aligned with objectives of the SDS-SEA. The **Changwon Declaration 2012**, which was signed during the 4th EAS Congress 2012 in Changwon, RO Korea, paved the way for the adoption of the blue economy paradigm in the region. The Changwon Declaration provides the following definition of blue economy:

> *"We understand the Blue Economy to be a practical ocean-based economic model using green infrastructure and technologies, innovative financing mechanisms, and proactive institutional arrangements for meeting the twin goals of protecting our oceans and coasts and enhancing their potential contribution to sustainable development, including improving human wellbeing, and reducing environmental risks and ecological scarcities."*[3]

The blue economy therefore promotes an alternative economic growth strategy combined with ocean management. It is focused on the economic perspective of the ocean and the natural

[2] FAO 2014, p.2; FAO 1989.

[3] Changwon Declaration Toward an Ocean-based Blue Economy: Moving Ahead with the Sustainable Development Strategy for the Seas of East Asia (Changwon, RO Korea, 2012).

capital assets of oceans, harnessing the oceans for economic growth, livelihoods, food security, recreation, resiliency, and other ecosystem services while meeting the goals of healthy oceans and sustainable and inclusive development. It has emerged as a feasible development path where growth in income and employment is driven by consumption and investments that reduce pollution, and prevent the loss of biodiversity and ecosystem services, and by innovations that enhance resource efficiency, and reduce carbon and water footprints. The blue economy also has equity and political stability considerations since a vast number of the world's poor rely upon the oceans for food, affordable protein, and employment.

Blue economy cannot happen without the enabling mechanisms like policies, regulations, incentives, access to science and technologies, financing, investments, integrated institutional arrangements, capacity, and stakeholder advocates. These are crucial to shift the levers from harmful activities to sustainable ocean economic activities together with conservation of habitats, fisheries, biodiversity, and other ocean resources, pollution management, climate change mitigation and adaptation, and disaster risk reduction.

1.4 Framework and Structure of the SOC Report

1.4.1 Framework for Analysis

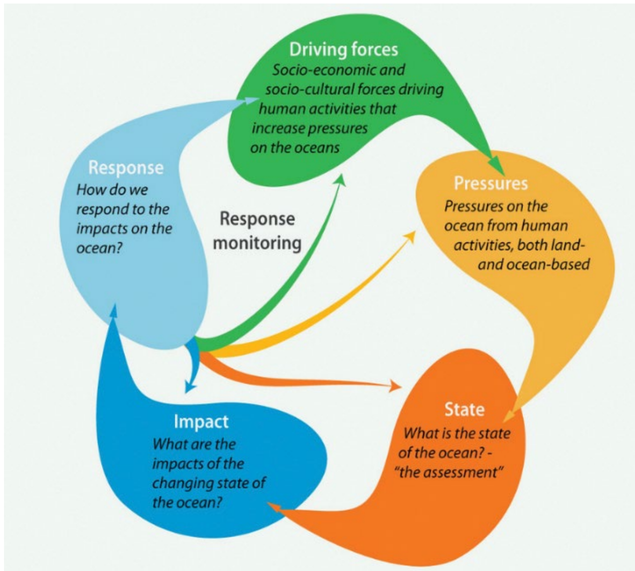
The development of the Regional SOC Report is anchored on the blue economy theme and entailed the use of the ***Drivers-Pressures-State-Impact-Response*** (DPSIR) framework for the analysis (**Figure 1.3**).

- *Drivers*: socioeconomic and socio-cultural forces driving human activities, which increase or mitigate pressures on the environment
- *Pressures*: the stresses that human activities place on the environment and ocean
- *State*: condition of the ocean environment, marine water quality, habitats, and biodiversity
- *Impacts*: effects of environmental degradation and changing state of the ocean
- *Response*: measures and interventions by government and society to address the environmental situation, improve the quality of life, and sustain the benefits from the ocean

The DPSIR framework was developed by the OECD in the 1990s and has been widely adopted in many sectors, including food, health, tourism, fisheries, pollution, biodiversity, etc. It has also been very widely used to determine the links between human pressures and state-changes in marine and coastal ecosystems. The DPSIR framework presents a logical, stepwise chain of cause-effect-control events that describe the progression from identification of a problem to its management (**Figure 1.3**).

There are now 25 ocean-related derivative DPSIR schemes and a widespread and increasing usage of the DPSIR-type conceptual framework as a means of structuring and analysing information in management and decision-making across ecosystems.[4] The first World Ocean Assessment (WOA-I of 2016), which is the outcome of the first cycle of the *Regular Process for Global Reporting and Assessment of the State of the Marine Environment, Including Socioeconomic Aspects*, used the DPSIR framework.[5]

Figure 1.3: Schematic Diagram of the DPSIR Approach for the First World Ocean Assessment.



Source: United Nations 2016.

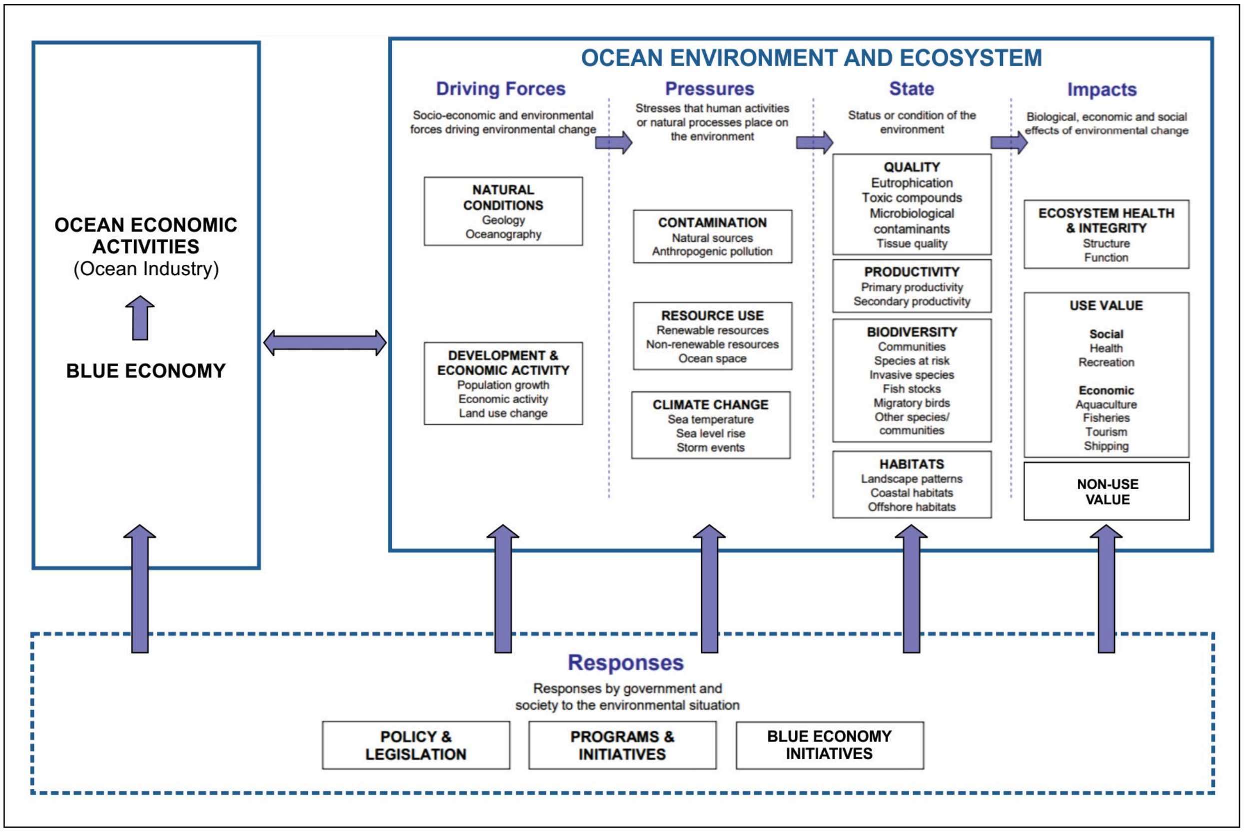
The DPSIR framework is useful for a number of features, including:

- The potential to act as a holistic and valuable tool for analysing cause-effect-response links, determining management measures and communicating these aspects[6]
- The potential to be a visualisation tool for complex interactions, thus making it valuable for the range of stakeholders involved in managing the marine system
- The flexibility to be applied across many systems and geographical areas, enabling to link marine systems, and it can show the connectivity between adjacent systems.

In developing the RSOC Report, the DPSIR framework is seen as giving a structure within which to present the information needed to enable feedback to policy makers on blue economy and ocean issues and the resulting impact of the political choices made, or to be made in the future. It also shows the substructures and indicators within the DPSIR components, and linkages (**Figure 1.4**). The National SOC Reports also used this framework.

[4] Patricio *et al.*, 2016 (https://www.frontiersin.org/articles/10.3389/fmars.2016.00177/full)
[5] UN, 2015. (https://www.un.org/regularprocess/content/first-world-ocean-assessment)
[6] Patricio *et al.*, 2016. (https://www.frontiersin.org/articles/10.3389/fmars.2016.00177/full)

Figure 1.4: DPSIR Framework in the Blue Economy Context.



1.4.2 Scope and Caveats

The RSOC report is the product of review of literature and desktop research of data, statistics, and documents from the official portals and websites of the National Focal Points of PEMSEA, and other key national government agencies, academe, research institutions, regional and international organizations, NGOs, scientific bodies, etc. The scope of the RSOC report is at regional level, and it consolidates the information from the National State of Oceans and Coasts (NSOC) reports as well as inputs from the ICM sites and Partners on best practices and local coastal governance. All data presented in this report are therefore sourced from available related literature, published reports, and online portals, and benefited from consultations with PEMSEA's Country and Non-Country Partners. This report reviews national, sectoral, local, regional, and collective accomplishments, examines the challenges, gaps and needs, identifies key policies and strategic action plans, captures best practices and lessons learned, and identifies opportunities for moving forward that build on existing strengths.

The **RSOC 2018 Report** provides the **Executive Summary** of the NSOC Reports and Policy Review Briefs, and offers an initial stocktaking of the blue economy, and the baseline assessment, which will be useful for future monitoring and reporting. The **RSOC 2021 Report** is the full report and contains updated information, and data that are available as of end of 2020, but excludes the period of the COVID-19 pandemic. A supplemental report to the RSOC 2021 was also prepared to discuss the impacts of the pandemic on the ocean economy, and ways to move forward and recover through the blue economy way.

The **RSOC 2021 report** presents the description of the following:

Part 1 provides an overview of the wealth of the East Asian Seas Region - the various seas, large marine ecosystems (LMEs) and straits from which the natural oceanic capital is derived, the produced capital as shown by the economies in the region, and the human and social capital from the different peoples living in this dynamic region. Section 2 provides information on the *geographical and oceanographic* features of the East Asian Seas, and the *demographic and socioeconomic conditions*, which have implications on the developments in the ocean economy, and impacts on resources, environment, and climate. These socioeconomic features are forces driving environmental, economic, and institutional changes. The last section of Part 1 focuses on the ocean wealth, which consists of the (a) natural capital and coastal and marine ecosystem services, and (b) produced capital and flows of goods and services from the ocean-based and -related industries. This section shows the value of the oceans in terms of the gross value added of the different ocean industries, and their contribution to the country's gross domestic product (GDP) and employment, as well as the value of coastal and marine ecosystem services.

Part 2 describes the *status of various ocean industries*, the pressures and challenges, and the response measures in terms of *policies, actions, and blue economy initiatives*. The blue economy has two dimensions: the ocean industry, and the oceans and ecosystems, and these two are interlinked, and must be sustainable and resilient. Oceans and the coastal and marine ecosystems contribute a significant amount to the national economies, and to the incomes, livelihood and welfare in the coastal communities as well as provide important ecosystem services, such as food, recreation, shoreline protection, waste assimilation, carbon sequestration, etc.

This part of the report also highlights the *blue economy initiatives* as a transformational approach towards an innovative and sustainable framework for managing our ocean economy while protecting our ocean and coastal resources. Blue economy offers an alternative paradigm, and it is one of the promising answers to the country's need for restoring and managing the oceanic natural capital and achieving more sustainable, inclusive, and climate resilient ocean economic activities. Examples of such initiatives, best practices, innovations, and emerging industries are discussed in this section to show the developments and opportunities for investments and partnerships in blue economy in the EAS Region. These include sustainable and climate-smart fisheries and aquaculture; ecotourism; green and smart ports and marine transportation; green shipbuilding; marine renewable energy; marine biotechnology; deep seawater utilization.

Part 3 describes the *state of ocean health underpinning the blue economy*, in particular, the current marine water quality, status of coastal and marine habitats and biodiversity, and the ocean-climate nexus. Large marine ecosystems (LMEs) in the region and transboundary issues are also presented in this part of the report. Identifying the socioeconomic forces that are driving environmental changes, the pressures that affect the natural environment, including climate change, and the impacts that these pressures produce are key to creating appropriate responses and solutions to the current problems and the associated sustainability of the ocean economy. Examples of policies, programs, and good practices in conservation, pollution management, and circular economy are provided in this section to illustrate the doable solution options that can be replicated and scaled up.

Part 4 of this report focuses on *governance* structure enabling and supporting blue economy development: policies and laws, institutional arrangements, stakeholder participation, ocean financing, and knowledge management, including traditional knowledge. These mechanisms take into consideration that synergies and tradeoffs exist between the various ocean economic sectors, and between the many different aspects of ocean sustainability and resiliency.

The RSOC Report is limited by accessibility and availability of data on ocean economy, marine water quality, and more robust studies and estimation of the value of coastal and marine ecosystem services. Improvements in future RSOC reports would entail the following:

- The ocean accounts need to be further developed. Backward and forward linkages, trade and multiplier effects of the ocean-based sectors have to be assessed also to show the wider economic contribution of the ocean economy.
- Regular monitoring of habitats, marine water quality (coastal and offshore), fishery resources, habitats, and biodiversity are essential to see the impacts of human activities, trends and changes, as well as the effectiveness and gaps of policies and management interventions.
- The incremental value of the blue economy initiatives should be measured to demonstrate their contribution to the national economy, sectoral value added, incomes, jobs, climate resiliency, and improvement of the environment and well-being.

Box 1. Setting the Scene

An *Inception Workshop on Blue Economy Assessment* was held at the PEMSEA Resource Facility (PRF) Office on 28-30 July 2015. Fifteen participants from China, Indonesia, Malaysia, the Philippines, RO Korea, Thailand and Viet Nam agreed to work on the assessment of ocean economy, ecosystem services, and investment opportunities for sustainable, inclusive, and resilient blue economy development. The blue economy assessment aimed to strengthen understanding of the role of the ocean and its contribution to the national economy, livelihoods and wellbeing; impacts of human activities on ocean health and sustainability; blue economy initiatives; potential areas for investments in environmentally-sound technologies and infrastructure; and the interventions and innovative mechanisms

Box 1. Setting the Scene (cont.)

needed to respond to changing environments and climate. The participants also concurred to present the results of their blue economy assessment work during the EAS Congress 2015 in Da Nang, Viet Nam.

Presentations made during the workshop, "*Blue Economy Development: Where are we now? Where are we headed?*" at the EAS Congress 2015, provided an initial assessment of ocean economy, ocean health and innovative investments for blue economy development in seven EAS countries. Discussions and recommendations during the Congress workshop focused on:

- developing ocean economy-environmental accounts, and quantifying ocean wealth in metrics that are understandable and usable by policy- and decision-makers
- using the State of Ocean and Coasts (SOCs) reporting system as the platform to show the status of the ocean economy and ocean health, gaps, solution options and best practices, and areas for potential growth and investments
- applying the SOC reports in: (i) formulating economic development plans and investment programs that incorporate sustainability and inclusivity objectives in the coastal and marine areas; (ii) drawing up support for ecosystem protection for climate resilient communities; and (iii) designing combined carrot-and-stick mechanisms to refine policies and laws and make them more implementable by the private sector and communities.

The work done in 2015, including the presentations during the blue economy workshop at the EAS Congress 2015, paved the way for the development of national and regional SOC reports. In April 2016, a *Regional Planning Workshop on the Development of a State of Ocean and Coasts (SOC) Report for the Seas of East Asia* was held at the PEMSEA Office Building in Quezon City, Philippines. Representatives from 13 international organizations and regional programmes participated and shared their views and perspectives on blue economy and the SOC report. They provided suggestions on key topics and indicators to be included in the SOC report. Available information and studies from their respective agencies and other sources of information were also discussed. The participants called attention to the issues, challenges, solution options, and examples of good practices. Agreement was reached among the participants on the proposed outline for a regional SOC report, and to continue their collaboration by sharing their expertise and providing technical guidance as needed.

The value of extending the work that was initiated in 2015 was recognized and developing the National State of Ocean and Coasts (NSOC) Reports was considered as important

Box 1. Setting the Scene (cont.)

building blocks of the Regional SOC Report, and to put together a comprehensive picture of the blue economy development in the region and implementation of the SDS-SEA.

Thereafter, a series of country dialogues were held to discuss and agree on the Terms of Reference for the development of the NSOC Reports. Inception Workshops were organized by Country Partners and with support from PRF and in collaboration with Non-Country partners and various agencies and stakeholders. The participants from the Regional Planning Workshop and the various country Inception Workshops also agreed to share information and contribute to the development of the regional and national SOC reports.

The draft NSOC Reports, and blue economy initiatives of Non-Country Partners and other development partners were presented during the Regional *Blue Economy Forum* held in Bangkok, Thailand on 14-15 November 2017. The information shared during this forum were used in refining the NSOC Reports and developing the Regional SOC Report.

In line with meeting Target 2 of the Da Nang Compact 2015, the Executive Summary of the Regional SOC Report and Summary Briefs of the *NSOC 2018: Blue Economy Growth* Reports were shared during the EAS Congress 2018, which was held in Iloilo City, Philippines, and presented at the Ministerial Forum on 29 November 2018.

The NSOC Reports are available for downloading at www.pemsea.org/publications/reports.

Preah Sihanouk Province coastline and ports. *(Photo by Preah Sihanouk Province)*

2 Major Driving Forces and Challenges for the Future

"The greatest threat to our planet is the belief that someone else will save it."

- **Robert Swan**, OBE (polar explorer, UN Goodwill Ambassador for Youth)

Recent developments and important factors have been shaping the coastal and marine areas of the EAS Region. Different environmental pressures have different socioeconomic and policy drivers.

"Changes in marine ecosystem dynamics are influenced by socioeconomic activities (for example, fishing, pollution) and human-induced biophysical change (for example, temperature, ocean acidification) and can interact and severely impact marine ecosystem dynamics and the ecosystem services they generate to society. Understanding these **direct**—or **proximate**—interactions is an important step towards sustainable use of marine ecosystems. However, proximate interactions are embedded in a much broader socioeconomic context where, for example, economy through trade and finance, human migration and technological advances, operate and interact at a global scale. These **indirect**—or **distal**—interactions add dimensionality and complexity to the global marine social-ecological system."[7]

In broad terms, the coastal and marine sectors like all other sectors respond to macro-level dynamics. The factors that could drive the ecosystem, environmental and climate changes and create pressures on the ocean include:

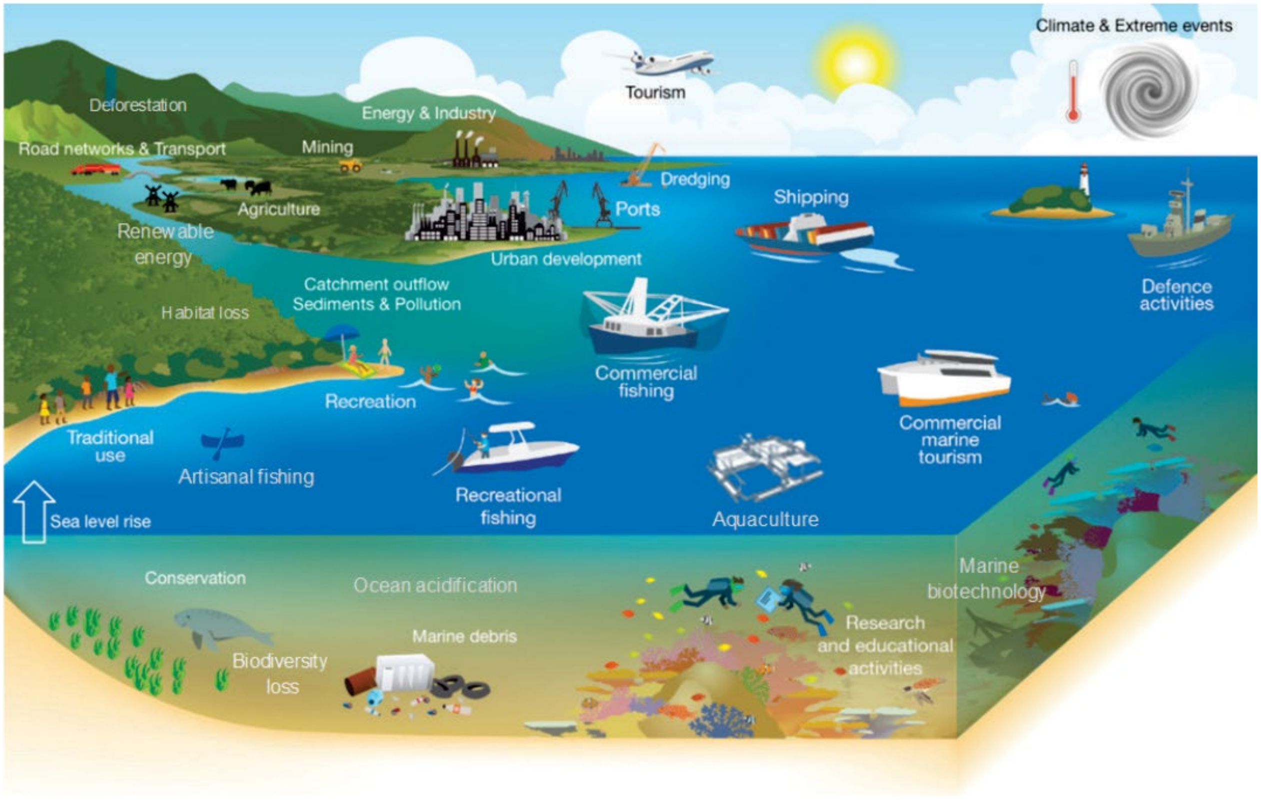
- population growth and changes in demographic attributes (such as: rural/urban balance; population density and population settlements in coastal areas; dependency on coastal and marine resources; age-sex structure and dependency ratio)
- economic growth (increases in gross domestic product or GDP, gross national income (GNI), including sectoral contributions to GDP, trade, technological developments and improved productivity, increasing per capita GDP and GNI, and related changes in personal wealth, prosperity, consumption and production patterns)
- changes in social dimensions (e.g., changes associated with cultural, ethnic, and gender equity issues; improved human capital, education, health, and welfare; social developments due to increased access to energy, water, other resources, technologies, and other social services; changes in aspirations and expectations, such as greater interest in environmental issues)

7 Österblom, *et al*. 2017.

- changes in coastal land- and sea-use (including traditional uses, urbanization, increased settlements in coastal areas, deforestation, conversion of coastal habitats, reclamation, infrastructure developments due to commercial, travel and tourism demands as well as climate change adaptation)
- evolution of policies (within and outside the ocean sector) and institutional/policy adaptations (such as economic deregulation, trade liberalization, decentralization, becoming parties to international agreements and the associated obligations, and recognition of traditional knowledge in biodiversity conservation and land and marine area management).

While the ocean has been viewed as the victim of climate and environmental changes, the ocean is also a source of solutions. Investments in sustainable ocean industries, human capital, governance, and innovations, combined with investments in environmental protection, and efforts aimed at addressing pollution, habitat loss, depletion of natural resources, and global warming can lead to future welfare increases. This RSOC Report describes the various response measures and good practices taking place to address the multiple pressures affecting the ocean and the people in the region. There are still huge gaps, and bold actions and collaboration are needed as we head towards 2030 where we have committed to achieve 17 sustainable development goals.

Figure 2.1: Human Activities, Ocean Environment and Climate Impacts.



This figure shows some of the human activities impacting our marine environment and climate, and that need to be considered when planning and making policies and management decisions.
Source: Beth Fulton, CSIRO (modified graphic).

Box 2.1. Wealth, Capital Stock, Ecosystem Services: Definition of Terms

The concepts of natural capital and ecosystem services are used in the context of accounting for a country's wealth, and not just accounting for income (GDP).

Capital is a **stock** concept, which yields a periodic income, which is a **flow** concept.

A country's **wealth** includes:

(1) **produced capital** (e.g., buildings, machinery, and infrastructure)
(2) **natural capital** (e.g., agricultural land, forests, mangroves, coral reefs, seagrass beds, wetlands, soils, minerals, and oil, coal and gas reserves, etc.)
(3) **human capital**: stock of intangible collective resources or assets like knowledge, education, training, intelligence, talents, experience, skills, health, habits, judgment, wisdom and other social and personality attributes (including creativity) possessed individually and collectively, and embodied in the ability to perform labor so as to produce economic value
(4) **net foreign assets**
(5) **social capital** (e.g., traditional knowledge, institutions, etc.)

Wealth accounting provides an estimate of the total wealth of nations by aggregating values of these different components of wealth. A change in wealth is an indicator to assess a country's potential to grow in the future. A fall in wealth indicates that a country is depleting its assets and may not be able to sustain its future GDP growth and development.

The **System of National Accounts** (SNA) is the internationally agreed standard set of recommendations for compiling and measuring economic activity of a country. **Gross Domestic Product** (GDP) represents the value of final goods and services produced by the economy during a given year. GDP is a flow that is measured in dollars, euros, or other currency units per year. However, GDP looks at only one part of economic performance—**income**—but says nothing about wealth and assets that underlie this income. For example, when a country exploits its minerals, it is depleting its wealth. The same holds true for over-exploiting fisheries or degrading water resources. These declining assets are 'invisible' in GDP, and often are not fully reflected in the SNA. Likewise, GDP does not fully capture the *human capital*. However, human capital affects economic growth and can help to develop an economy by expanding the knowledge and skills of its people.

The **System of Environmental-Economic Accounting** (SEEA) is a framework that integrates both economic and environmental data to provide a more comprehensive and multipurpose

Box 2.1. Wealth, Capital Stock, Ecosystem Services: Definition of Terms (cont.)

view of the interrelationships between the economy, the environment and ecosystems, and the stocks and changes in stocks of natural assets, as they bring benefits to humanity.

An **ecosystem** is a complex community of living organisms, their physical environment, and all their interrelationships in a particular unit of space, and these biotic and abiotic components are linked together through nutrient cycles and energy flows.

Natural capital is a way of thinking about nature as a *stock* that provides a flow of benefits to people and the economy. Natural capital consists of the stocks of **natural** assets – both biotic and abiotic. It includes air, water, soil, minerals, oil, gas, coal, forests, mangroves, coral reefs, seagrass beds, and all living things. It is from this natural capital that humans derive a wide range of goods and services, which make human life possible. The goods and services that natural capital provides, such as food, water, energy, or climate regulation, are called **ecosystem services**. These provide people everywhere with the means for healthy lives and underpin all economic activity.

Ecosystem services are the *flows* of benefits, which people gain from natural ecosystems, while **natural capital** consists of the *stock* of natural ecosystems or stock of renewable and non-renewable natural resources from which these benefits flow.

Healthy soil and clean water are components of natural capital, while food and water supply are the ecosystem services they provide, in particular, *provisioning* services. Similarly, rainforests and mangroves are components of natural capital, and they provide: (a) *provisioning* services like timber, food, and traditional medicines; (b) *cultural* services, such as spiritual value, education, and recreation; (c) *supporting* services, such as habitat for wildlife and nutrient cycling; and (d) *regulating* services, such as climate regulation, carbon sequestration, and protection from erosion and flooding.

Minerals, oil, gas, and coal are examples of non-renewable and depletable resources. Forests, fisheries, and water resources are renewable, but depletable.

Increasing pressures on nature, from climate change, pollution, over-exploitation of natural resources, and biodiversity loss, are degrading the ecosystems on which our economies depend on. This carries real and immediate risks for human life and businesses.

People are exposed to natural capital risks, which affect their food, water and energy security, health, climate and disaster resiliency, and productivity. Manufacturers must have access to

Box 2.1. Wealth, Capital Stock, Ecosystem Services: Definition of Terms (cont.)

water to process food and build cars and ships; the agriculture sector needs water, soils, and pollinators, like bees, to grow crops without excessive costs. Financial institutions are, in turn, exposed to natural capital risks that affect the people and businesses that they invest in, lend to, or insure.

Source: United Nations (https://seea.un.org/); World Bank 2006; Lange, et al. 2018.

2.1 The East Asian Seas

2.1.1 From the Pacific Ocean to the Indian Ocean: The Seas, Islands and Straits in Between

The major Northeast Asian waters are the Sea of Japan, Yellow Sea, Bohai Sea, and East China Sea. The major Southeast Asian waters are the South China Sea, Sulu-Celebes Seas, Indonesian Seas, Arafura-Timor Seas, Gulf of Thailand, and Andaman Sea.

Sea of Japan. Starting from the north of the EAS region, the *Sea of Japan* is a marginal sea bounded by Japan, Sakhalin Island to the east, and by Russia and the Korean Peninsula to the west. The Japanese archipelago separates the sea from the Pacific Ocean.

Philippine Sea. Starting from the east of the EAS Region, the Philippine Sea reaches out to the Pacific Ocean. Due to the subduction of the Pacific tectonic plate below the Philippine Sea Plate, the sea plunges to the greatest depths of the planet at the Mariana trench, reaching a staggering depth of 10.9 km. On the other side of the Philippine Sea plate is the Philippine trench, which is the third deepest point in the world.

Yellow Sea. Located between China (mainland) and the Korean Peninsula is the Yellow Sea. It is situated to the north of the East China Sea, which it bounds on a line running from the mouth of the Yangtze River to Jeju Island off RO Korea. Its name comes from the sand particles from the Gobi Desert sandstorms, which turn the surface of the sea to golden yellow. The northern extension of the Yellow Sea is called the Korea Bay. The innermost bay of the Yellow Sea is called the Bohai Sea. The Yellow River (through Shandong province) and Hai He river (through Beijing and Tianjin) flow into the Bohai Sea. Deposits of sand and silt from those rivers contribute to the sea color.

East China Sea. To the north of the South China Sea, and east of China is the East China Sea. The countries which border the East China Sea are China, RO Korea, and Japan. It is bordered on the east by the Japanese islands of Kyushu and Ryukyu Islands, which separates it from the Pacific

Ocean. The East China Sea connects with the Sea of Japan through the Korea Strait, and it opens to the north into the Yellow Sea. The Yangtze River (Chang Jiang) is the largest river flowing into the East China Sea.

South China Sea. The South China Sea stretches Viet Nam and China to the north across to the Philippines in the east, and to the shores of Borneo to the south. It is a marginal sea encompassing an area from the Taiwan Strait to the Karimata and Malacca Straits of around 3,500,000 km^2. To the west, this sea comes to a head in the shallow *Gulf of Thailand*. This is one of the few parts of Asia where the flow of water is slow, meaning the water is not as rich in nutrients as other seas in the region. To the east, the sea increases in depth as it reaches the Philippines. The island of Palawan (Philippines) separates the South China Sea and the Sulu Sea.

The South China Sea contains over 250 small islands, atolls, cays, shoals, reefs, and sandbars, many of which are naturally under water at high tide, and some are permanently submerged. The largest singular feature in the South China Sea is a 100 km-wide seamount called the Reed Bank, in the northeast of the Spratly Islands group, near the island of Palawan, Philippines.

The major rivers draining into the South China Sea are: (a) the tributaries of the Pearl River Delta, south of Guangzhou, China, including the Xi River; (b) the Red River at Hai Phong in Viet Nam, and (c) the Mekong River, near Ho Chi Minh City, Viet Nam. The wet summer season causes the Mekong to triple its annual average flow, and it causes an even greater relative change in the flow of the Red River.

Sulu Sea. Within the Philippines, the Sulu Sea is one of the smallest, but most productive of Asia's seas, marking the northern tip of the Coral Triangle, the most biologically diverse marine region on earth. It is bounded by Palawan to the west, the islands of the Visayas and Mindanao in the Philippines to the east, northern Borneo to the southwest, and the Sulu archipelago in the southeast. The Sulu Sea is deep, bringing nutrient rich upwellings from great depths, which support the spectacular congregations of marine life found at sites, such as the Tubbataha Reefs. The Tubbataha Reef National Marine Park is one of the World Heritage Sites. The straits out of Sulu Sea include the Guimaras Strait, Iloilo Strait, and the Basilan Strait. The Panay Gulf is an extension of the Sulu Sea. The Sulu Sea also contains a number of islands. The Cuyo Islands and Cagayan Islands are part of the province of Palawan, and the Mapun and Turtle Islands are part of the province of Tawi-Tawi. Together with three islands of Malaysia and the surrounding waters and coral reefs, the Turtle Islands – one of the world's few remaining major nesting grounds for the green sea turtles – were jointly declared as **Turtle Islands Heritage Protected Area** by the governments of the Philippines and Malaysia in 1996.

The Mindoro Strait–Sibutu Passage pathway plays a significant role in influencing the Luzon Strait inflow to the South China Sea (SCS). This pathway is an important branch of the **SCS throughflow** into the Indonesian Seas. It is also the gateway for oceanic waves propagating clockwise around the Philippine Archipelago from the western Pacific Ocean into the South China Sea (Li et al., 2021).

Indonesian Sea. The Indonesian Sea represents the only pathway that connects the Pacific Ocean and Indian Ocean in the tropics, and therefore play a pivotal role in the coupled ocean and climate system ('ocean-climate nexus'). The transfer of tropical water from the Pacific to the Indian Ocean through the Indonesian Sea, a series of narrow straits and seas, is considered to be a first order factor in the heat and freshwater inventories of these oceans, and as such are linked by sea-air fluxes to the larger scale climate system, specifically El Niño-Southern Oscillation (ENSO), the Asian Monsoon, and the Indian Ocean Dipole (IOD).[8]

To the south of the Philippines, separated from the Sulu Sea by an ocean ridge, is the *Celebes Sea* or ***Sulawesi Sea***. It reaches the coast of northern Sulawesi, an incredibly rich and diverse part of Asia that is home to Bunaken Marine National Park, and the Lembeh Strait, which is considered by many to be the earth's engine room of marine evolution. The Celebes Sea is part of an ancient ocean basin and plummets to depths of over six (6) km. The *Sulu-Celebes Seas* form the apex of the Coral Triangle.

To the east, the Sulawesi (Celebes) Sea opens out in the Pacific Ocean, while to the south, it meets the *Makassar Strait*. This region sprung to prominence among scientists in the 19th century, when the ***Wallacea Line*** theory was proposed. This line passes from the Celebes Sea, through the straits of Makassar and Lombok then out into the Indian Ocean. It marks the boundary between two distinct groups of wildlife. To the south and east of the Wallacea Line, animals are of Australian origin, while to the west of this line, wildlife is distinctly Asian.

The Sulawesi island lies between Celebes Sea (or Sulawesi Sea), Banda Sea and Flores Sea. It is situated south of Mindanao and the Sulu archipelago of the Philippines, east of *Makassar Strait* and Borneo, and west of the Maluku Islands. It is one of the four Greater Sunda Islands, and the world's eleventh largest island. The landmass of Sulawesi includes four peninsulas, with three gulfs separating these peninsulas: the *Gulf of Tomini* between the northern Minahasa and East peninsulas; the *Tolo Gulf* between the East and Southeast peninsulas; and the Bone Gulf between the South and Southeast peninsulas. Wakatobi, in the south-eastern part of Sulawesi, is one of the few areas that has all three types of reef system – fringing reef, barrier reef, and atolls.

The greatest diversity of coral and fish species on earth is found in the tiny ***Halmahera Sea*** off the north-eastern tip of Western Papua (formerly known as Irian Jaya). Sitting almost exactly on the equator, this sea is home to 600 different species of coral and around 1300 fish species.

[8] Gordon, Arnold L. Indonesian Seas. (Accessed from: https://www.ldeo.columbia.edu/research/ocean-climate-physics/indonesian-seas).

The ***Molucca Sea*** borders the Sulawesi Sea to the west, and Banda Sea to the south. To the north is the Philippine Sea, and to the east is Halmahera Sea. The islands bordering the Molucca Sea include Sulawesi to the west, Halmahera to the northeast, Sula Islands, Buri and Ceram (Seram). The Molucca Sea is rich in corals and has many diving sites due to the deepness of its waters.

To the south of this area is the ***Banda Sea***. It is the sea in the Maluku islands, and surrounded by the Halmahera Sea, Ceram Sea and Molucca Sea. The Maluku Islands comprise a group of islands known in the past as the Moluccas or Spice Islands.

To the southeast of Banda Sea, the shallow ***Arafura Sea*** stretches across to the northern coast of Australia. The Arafura Sea is bordered by the ***Timor Sea*** to the west, *Banda Sea* and *Ceram Sea* to the northwest, the *Gulf of Carpentaria* and Australia to the south, and the *Torres Strait* to the east. The *Arafura Sea* is rich in fishery resources. Economically important species include Barramundi, grouper, Nemipteridae fishes, and Penaeid shrimp, among others. *Timor Sea* contains a number of reefs, uninhabited islands, and significant hydrocarbon reserves. The *Arafura-Timor Seas* are primarily shallow, except for a deep trough to the north. It empties out into the southern Indian Ocean to the west.

The ***Flores Sea*** is another incredibly productive sea, with spectacular marine life off the southern peninsulas of Sulawesi, and around Flores, Komodo and Sumbawa islands to the south. Flores Sea is bounded on the north by the island of Sulawesi, on the south by the Sunda islands of Flores and Sumbawa, *Bali Sea* to the west, *Java Sea* to the northwest, and the *Banda Sea* to the east and northeast. The Indian Ocean and *Savu Sea* lie to the south, but they are separated from the Flores Sea by various islands.

The straits between the island chain of Nusa Tengarra, including Flores, Sumbawa and Lombok, have some of the strongest currents on earth due to the ***Indonesian Throughflow***. This is a massive transference of water from the Pacific Ocean to the Indian Ocean, where the water flow has to squeeze through the small channels between the islands. These ripping currents result in healthy marine ecosystems as they flood the area with the nutrients required to support a huge array of life.

Bali, to the west of the Indonesian Throughflow, is where the Flores Sea meets the ***Java Sea***. The relatively shallow Java Sea separates Indonesia's most populous island of Java from Borneo, the third largest island, to the north. To the west, the Java Sea meets the island of Sumatra. The *Sunda Strait* between the Indonesian islands of Java and Sumatra connects the Java Sea to the Indian Ocean. To the northwest of Sumatra is the *Andaman Sea*, and to its south is the Indian Ocean.

The ***Natuna Sea*** is an extensive shallow sea located around Natuna Islands, extending south to Lingga and Tambelan archipelago in Riau Islands, and further south of Bangka Belitung Islands.

Most of the sea is located within Indonesian territorial waters, and it is geologically part of the Sunda Shelf. The Natuna Sea borders the *South China Sea* to the north and northeast, *Karimata Strait* to the southeast, and *Strait of Singapore* to the west.

From the South China Sea to the Andaman Sea, the main channel is the *Strait of Malacca*. It is a narrow, 890 km stretch of water between Peninsular Malaysia and Sumatra, but it is one of the most important shipping lanes in the world.

Andaman Sea. The Andaman Sea sits between the Indian Ocean and the coasts of Myanmar, Thailand, Malaysia and Indonesia, drifting into the Bay of Bengal in the north. Its western perimeter is marked by the remote Andaman Island chain. Thailand, Peninsular Malaysia, and Sumatra separate the Andaman Sea from the South China Sea.

Banyak Islands in Sumatra, Indonesia. *(Photo by Fabio Lamanna@Shutterstock/CC BY SA-4.0)*

Mangroves and limestone islands in Phang Nga Bay in Phuket, Thailand. *(Photo courtesy of The Luxury Signature)*

Figure 2.2: The Seas of East Asia.

Source: https://geopoliticalfutures.com/patrolling-seas-southeast-asia/

2.1.2 Oceanographic Features[9]

a. Currents and tides

Ocean currents and oceanographic processes have a substantial impact on the ecology of the region, influencing the availability of nutrients and driving the productivity, distribution and abundance of phytoplankton and fisheries. These processes affect the health and productivity of the marine ecosystems, including biodiversity.

9 For this section, the sources of information are: Gomez /UNEP 1990; UNEP/GIWA 2005 reports; www.britannica.com/place/East-China-Sea; www.britannica.com/place/Yellow-Sea.

The water mass of the EAS Region originates from the Pacific Ocean. The **North Equatorial Current** flows westwards, and upon reaching the Philippines, it splits into two main branches. The northward branch becomes the **Kuroshio Current**, and the southward branch, the **Mindanao Current**. The Kuroshio Current begins east of Northern Luzon as a swift and narrow segment of the western boundary current, and flows to the east coast of Taiwan, the East China Sea and the Sea of Japan. The Mindanao Current flows southeast along the coast of Mindanao Island, Philippines, with its main part entering the Celebes Sea (or Sulawesi Sea) through the straits between Mindanao, Sangir and Talaut Islands.

Winds also influence water circulation of the Kuroshio Current, the north-flowing western extension of the warm North Equatorial Current. Some of the Kuroshio enters the eastern part of the East China Sea to form the **Tsushima Current**. The Tsushima Current flows north into the Sea of Japan (or East Sea), while the main part of the current diverts eastward back out into the Pacific, south of Kyushu, and flows east of Japan.

The warm current of the Yellow Sea is a part of the Tsushima Current, which diverges near the western part of the Japanese island of Kyushu and flows at less than 0.8 km per hour northward into the middle of the Yellow Sea. Along the continental coasts, southward-flowing currents prevail, which strengthen markedly in the winter monsoon period, when the water is cold, turbid, and of low salinity.

The tides of the Southeast Asian waters are affected by both the Pacific and Indian Oceans. Diurnal tides predominate in the South China Sea and Java Sea whereas mixed tides prevail in the eastern Indonesian archipelago, the Philippines waters, the Andaman Sea, Straits of Malacca, and the shelf areas northeast of Australia.

The tidal range is high (4-8m) along the shallower west coast of the Korean peninsula, with a maximum spring tide of almost 8.2 m. Along the coasts of China, the tidal range is about 0.9 to 3 m, except around the Bo Hai Sea, where it is somewhat higher. In the Yellow Sea, the tides are semidiurnal (i.e., they rise twice daily). The tidal system rotates in a counter clockwise direction. The speed of the tidal current is generally less than 1.6 km per hour in the middle of the sea, but, near the coasts and in the straits and channels, stronger currents of more than 5.6 km per hour are recorded.

The Sea of Japan has almost no tides due to its nearly complete enclosure from the Pacific Ocean. The Sea of Japan is a classic semi-enclosed sea since its connections with adjacent bodies of water are greatly restricted by the narrow straits. The near isolation of the Sea of Japan also reflects in the fauna species and in the water salinity, which is lower than in the ocean. The sea has no large islands, bays, or capes, and few rivers discharge into the sea. Its water balance is mostly determined by the inflow and outflow through the straits connecting it to the neighboring seas and Pacific Ocean.

b. Monsoon

Located between the Asian and the Australian continents, the Southeast Asian region is strongly influenced by monsoons. The north monsoon in Southeast Asia lasts from December to February, and the south monsoon from June to August. The rest of the year represents the transition from the north to the south monsoons (March to May), and from the south to the north monsoons (September to November).

Monsoons control the sea surface currents as well as the exchange of water between the South China Sea and adjacent bodies of water. In August, the surface flow into the South China Sea is from the south from the Java Sea through the Karimata and Gelasa (Gasper) Straits. Near the mainland, the general flow is northeasterly, passing out through the Taiwan and Luzon straits. There is a weak countercurrent on the eastern side of the sea. In February, the flow is generally to the southwest; the strongest flow occurs in summer along the bulging part of Viet Nam, with speeds of up to 5.6 km per hour generated by the strong southwestern monsoon.

Weather in the East China Sea is likewise dominated by the monsoon wind system, the result of differential heating between land and water. In summer, the Asian landmass is much warmer than the sea, while in winter, it is much colder, particularly in the Plateau of Tibet. Summer heating of air masses over Asia builds areas of low pressure, and creates the monsoonal winds, which in this season blow predominantly from the southeast. This brings in warm, moist air from the western Pacific, producing a rainy summer season that is accompanied by typhoons. In winter, the situation is reversed: winds blow predominantly from the north, bringing with them cold, dry air from the continent.

Generally, the climate in the Yellow Sea is characterized by very cold, dry winters and wet, warm summers. From late November to March a strong northerly monsoon prevails, which in the Bo Hai Sea is sometimes accompanied by severe blizzards. Typhoons occur in summer, and in the colder season there are occasional storms.

The Sea of Japan influences the climate of Japan because of its relatively warm waters; evaporation is especially noticeable in winter, when an enormous quantity of water vapour rises in the region between the cold, dry polar air mass and the warm, moist tropical air mass. From December to March, the prevailing northwest monsoon wind carries cold and dry continental polar air masses over the warmer waters of the sea, resulting in snow along the mountainous western coasts of Japan. In summer, the southernly tropical monsoon blows from the North Pacific onto the Asian mainland, causing dense fog when its warm and moist winds blow over the cold currents that prevail over the northern part of the sea at that season. The winter monsoon brings rough seas and causes coastal erosion along the western coasts of Japan. The northern part of the sea, especially off the Siberian coast as well as in the Tatar Strait, freezes in winter. Due to convection, melted ice feeds the cold currents in that part of the sea in spring and summer.

c. Sea surface temperature

Since the Southeast Asian waters straddle the equator, the surface water is characterized by high temperature, with small annual temperature variation. During the north monsoon, high sea surface temperature of 28°-30°C prevail on the west coast of Sumatra and the eastern Indonesian archipelago waters. However, colder water (26°-27°C) is found in the South China Sea due to the inflow of water masses from the higher latitudes. Temperatures of 26°-27°C also prevail in the Arafura Seas and the south coast of Java.

The near-surface waters in South China Sea are relatively warm (about 29°C in the summer) because of the low latitude and a tendency for the equatorial current to feed warm water into the area. In early summer, wind from the southwest not only moves the surface water to the northeast but causes it to be displaced off the coast. As a result, upwelling areas having colder surface temperatures and higher nutrient content are found off central Viet Nam. In winter, the general surface temperature is cooler, ranging from about 21°C in the north to 27°C in the south.

Strengthened by monsoon winds, the Kuroshio Current is at its widest and fastest in summer, and the axis is displaced well into the East China Sea. This warmed surface water varies from 30°C in the south to 25°C in the north. In winter, northerly monsoon winds modify the circulation, and the north-flowing Kuroshio, though still important, is reduced in strength, while southerly flowing coastal currents are strengthened. This brings in colder water, with temperatures of 5°C in the north to 23°C in the south. Some warm water also enters the sea via the Luzon and Taiwan straits.

Because of the constricting nature of the adjoining Yellow Sea and the funnel shape of some of the inlets on the mainland, tidal ranges are especially high along the coast of China. For example, the spring tide range, which is highest in summer and winter, is as much as 23 feet (7 m) at Sansha Bay and 30 feet (9 m) at Hangzhou Bay.

The innermost coastal sections of the Bohai Sea freeze in winter, and drift ice and ice fields hinder navigation in parts of the Yellow Sea. Surface temperature ranges from freezing level in winter in the Bohai Sea to summer temperatures of 22-28 °C in the shallower parts. In winter, the temperature and salinity in the sea are homogenous from surface to bottom. In spring and summer, the upper layer is warmed and diluted by the freshwater from rivers, while the deeper water remains cold and saline. This deep layer of cold water stagnates and moves slowly south in summer. Around this mass of water, especially at its southern tip, commercial bottom-dwelling fishes are found. Air temperatures range from 10-28 °C and precipitation from about 20 inches (500 mm) in the north to 40 inches (1,000 mm) in the south. Sea fog is frequent along the coasts, especially in the upwelling cold-water areas.

The waters of the Sea of Japan generally circulate in a counterclockwise pattern. A branch of the Kuroshio Current, the Tsushima Current, together with its northern branch, the **East Korea Warm Current**, flows north, bringing warmer and more saline water. There they merge into the **Tsugaru Current**, and flow into the Pacific Ocean through the Tsugaru Strait. They also feed the **Soya Current** and exit through the La Perouse Strait to the Sea of Okhotsk. The returning branch, which is composed of three cold currents—the Liman, North Korea, and Central (or Mid-) Japan Sea currents—brings cooler, relatively fresh water southward, along the coast of the Asian mainland.

d. Salinity

The high temperature combined with the influence of low salinity reduced the density of the surface water in the Southeast Asian seas. The large excess rainfall over evaporation causes an average salinity of less than 34 parts per thousand (ppt) within a region enclosed by a line running from Sri Lanka, islands of Sumatra, Java, Borneo and Philippines, to Taiwan (China).

The salinity in Southeast Asia is extremely variable. The effects of high rainfall, runoff of many large rivers, and geographical subdivisions of the seas are responsible for this feature. The distribution of discharges from land, presence of large bays and channels, with little water exchange contribute to the general lower salinity. The monsoons cause rainy and dry seasons, which then affect the annual variation of salinity.

The dominant salinity in the Yellow Sea region is relatively low: in the Bohai Sea, it is 30 to 31 parts per thousand (ppt), while in the Yellow Sea proper it is 31 to 33 ppt. During the southwest monsoon season (June to August), the increased rainfall and runoff cause a further reduction in salinity in the upper layer.

The hydrological isolation of the Sea of Japan results in slightly lower average water salinity (34.09 ppt) compared with the Pacific Ocean. In winter, the highest salinity at 34.5 ppt is observed in the south where evaporation dominates over precipitation. It is the lowest at 33.8 ppt in the south-east and south-west because of frequent rains and remains at about 34.09 ppt in most other parts. Thawing of ice in spring reduces water salinity in the north, but it remains high at 34.6 - 34.7 ppt in the south, partly because of the inflow of salty water through the Korea Strait.

2.2 The People and Economies of the EAS Region

2.2.1 Demographic Features

One of the drivers of environmental change is population growth and demographic change. More people require more food, water, energy, and resources.

Home to 2.13 billion people, the EAS region has been witnessing dramatic shifts in its population. Demographic changes and human development are interrelated and influence each other. Many countries in the region have improved their living standards as population growth was managed. Since 1950, the share of children has consistently contracted, while the shares of working-age and elderly people have steadily risen. The smaller shares of young and old dependents, and larger shares of people in their productive working years mean more people who can power development. However, countries like Japan, RO Korea, Singapore, and Thailand are facing challenges from aging population, where at least 14 percent of the population is 60 years and above. Aging populations are about to fundamentally change societies, business strategies, and government policies. Countries affected by a growing aging population need policies that address both the sustainable growth of their economies and the rights and welfare of the elderly. On the other hand, countries with a very youthful population need to invest more in schools, while those with a large working-age population need to create more job opportunities.

The countries with population density of >300 million people per km^2 are Singapore, RO Korea, Philippines, Japan, and Viet Nam. High population density requires better planning and coordination among various services and allocation of required infrastructure and public spaces.

The percentage of urban population in the EAS region is increasing as the urban economy grows and attracts rural people to the urban working areas. As a result, rural population is experiencing a decline, thereby, creating pressures on both agricultural production and urban infrastructure and services. Urban population is more than 50 percent of total population in China, Indonesia, Japan, DPR Korea, RO Korea, Malaysia, Singapore, and Thailand. The rural population still dominates in Cambodia, Lao PDR, Timor-Leste, and Viet Nam. Meanwhile, majority of the population in Indonesia, Japan, Malaysia, Philippines, Singapore, and Timor-Leste live in coastal areas.

Urban areas will need more housing, water supply, energy, roads, transportation systems, sanitation, services, and wastewater and solid waste management, etc. as more people move to urban areas. Urbanization has direct effects on biodiversity and the state of the coastal and marine environment. Building along the foreshore can affect the coastal landscape and processes. The expansion of coastal urban development places increasing pressure on the natural environment through the effects of land clearing, habitat conversion, groundwater extraction, waste disposal, and air and water pollution. These pressures are expected to increase as the population and rate of urbanization increase. Thus, urban areas need new environmental management measures to protect their environments, clean up pollution and waste sites, reduce water footprints, reduce carbon emissions, improve energy efficiency, develop renewable energy and cleaner production technologies, and adopt green growth strategies as highlighted in the SDGs. Such measures should also be coordinated with job creation and provision of social services.

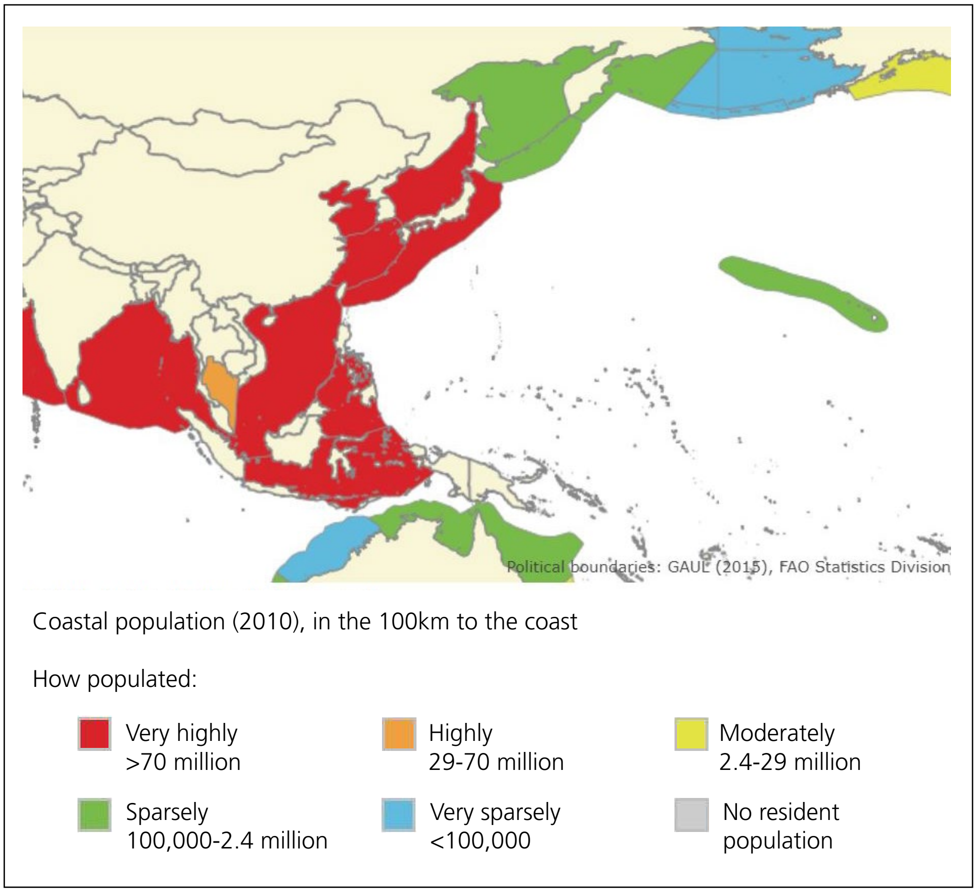
Table 2.1: Land Area and Demographic Features in 2019.

Country	Land Area (km^2)	Population (million)	Population Growth (annual %)	Population Density (people per km^2)	Urban Population (% of total population)	Coastal Population* (% of total population)	Age Dependency Ratio (% of working-age population)
Cambodia	176,520	16.5	1.5	93.4	23.8	7.1 (2015)	86.4
China	9,388,210	1,397.7	0.4	148.9	60.3	43.3 (2015)	145.3
Indonesia	1,811,570	270.6	1.1	149.4	56.0	65.0 (2018)	140.5
Japan	364,560	126.3	-0.2	346.4	91.7	80.0 (2009)**	348.2
Korea, DPR	120,410	25.7	0.5	213.2	62.1	--	29.0
Korea, RO	97,489	51.7	0.2	530.4	81.4	27.2 (2016)	90.9
Lao PDR	230,800	71.7	1.5	31.1	35.6	--	519.6
Malaysia	328,550	31.9	1.3	97.3	76.6	60.0 (2017)	208.3
Philippines	298,170	108.1	1.4	362.6	47.2	62.0 (2017)	332.6
Singapore	709	5.7	1.1	8,044.5	100.0	100.0 (2017)	7,779.3
Thailand	510,890	69.6	0.3	136.2	50.7	23.44 (2015)	132.5
Timor-Leste	14,870	1.3	1.9	87.0	31.0	90.0 (2017)	77.9
Viet Nam	310,070	96.5	1.0	311.1	36.6	49.4 (2018)	292.6

Sources: World Bank, 2021a, b, c, d, e, f, g, h, i, j, k, l, m.
* NSOC Reports of Cambodia, China, Indonesia, Malaysia, Philippines, RO Korea, Singapore, Thailand, Timor-Leste and Viet Nam.
** Hiroyuki Nakahara. 2009.

A day at the beach in Busan, RO Korea. *(Photo by M. Ebarvia)*

Figure 2.3: Coastal Population in the LMEs.



Source: Liana McManus in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

2.2.2 Economic Development

The EAS region is expected to continue to be a major driver of global growth. GDP growth rates in the EAS economies in 2015-2019 have been positive (**Table 2.2**). EAS is home to the second and third largest economies – China and Japan, respectively, and RO Korea is the 10th largest economy in the world.

Growth in the EAS region since the World War II has been formed by waves of growth. These successive waves were grounded on lessons learned from the effective institutions, policies, and technologies of previous waves of growing economies—termed the "flying geese" effect.[10] Japan started the process and other countries followed. The first wave was growth in Japan in the 1950s-1960s, followed by the second wave of growth in the "Four Tigers" — Hong Kong, RO Korea, Singapore, and Taiwan in the 1970s-1980s. Innovation and technology are the key factors that have underpinned the export competitiveness of Japan and the Four Tigers and fueled their

[10] Kojima, 2000.

remarkable economic rise. The third wave of growth was in China, which, following its entry to the World Trade Organization in 2001, achieved double-digit growth rates. Its economic growth has since tapered down to single-digit rates, as its economy is rebalancing from investment-led to consumption-led growth. The fourth wave of growth is apparent in the ASEAN countries.

Table 2.2: Country Macroeconomic Indicators.

COUNTRY	GROSS DOMESTIC PRODUCT (GDP) (Constant 2010 US$, in billions)			GROSS NATIONAL INCOME (GNI) (Constant 2010 US$, in billions)			UNEMPLOYMENT (modeled ILO estimate) (% of Total Labor Force)		
	2015	2018	2019	2015	2018	2019	2015	2018	2019
Cambodia	15.9	19.5	20.9	15.9	18.1	20.2	0.39	0.65	0.68
China	8,913.3	10,872.98	11,537.2	8,879.81	10,833.16	--	4.63	4.28	4.32
Indonesia	988.1	1,146.9	1,204.5	956.49	1,114.64	1,169.57	4.51	4.51	4.69
Japan	5,988.7	6,170.3	6,210.7	6,218.39	6,394.19	--	3.40	3.40	3.29
Korea, RO	1,329.6	1,449.7	1,479.2	1,333.82	1,453.53	1,492.54	3.60	3.85	4.15
Lao, PDR	10.4	12.6	13.2	9.90	--	--	0.69	0.64	0.63
Malaysia	330.32	382.49	398.95	321.43	370.71	388.41	3.10	3.35	3.32
Philippines	279.30	340.30	360.86	310.70	375.15	394.98	3.07	2.34	2.15
Singapore	298.94	333.10	335.54	278.63	299.49	303.13	3.79	4.02	4.11
Thailand	394.51	442.26	452.75	374.17	420.42	435.81	0.60	0.77	0.75
Timor-Leste	1.09	1.07	1.11	2.16	1.74	--	4.45	4.48	4.55
Viet Nam	154.51	187.69	200.86	146.35	175.14	188.36	2.13	1.99	2.01

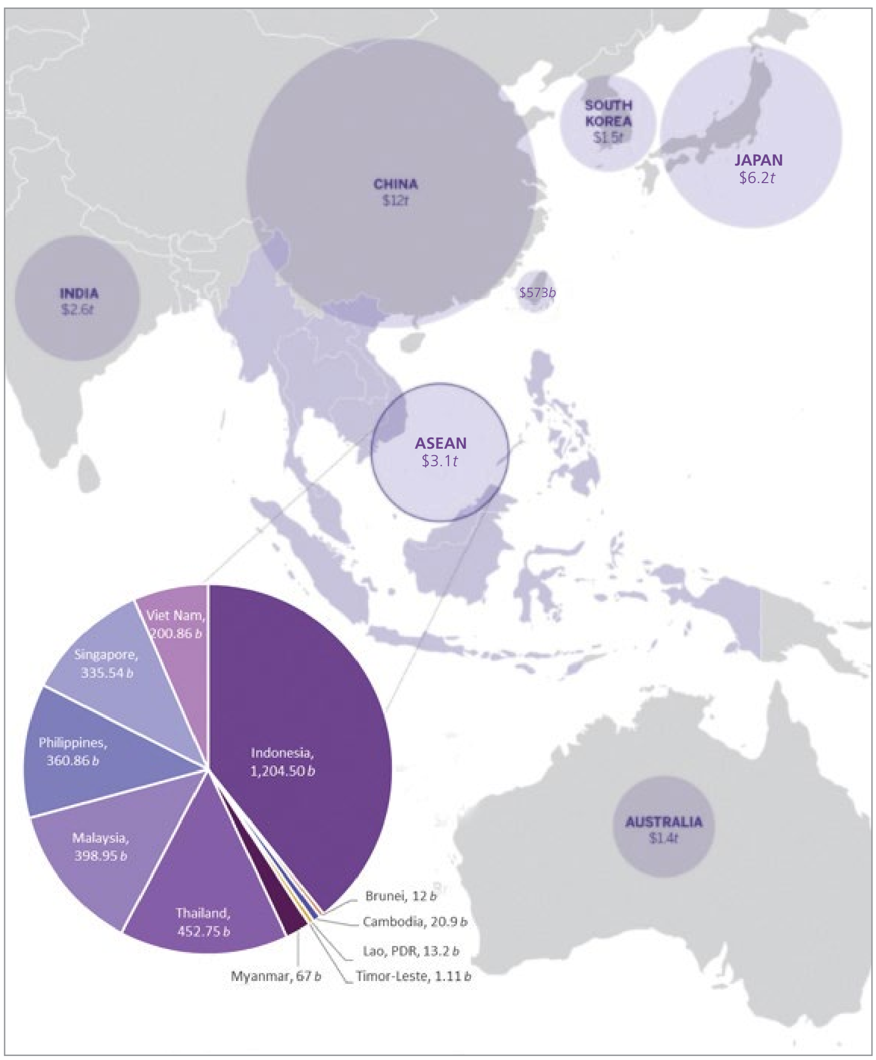
COUNTRY	INFLATION, CONSUMER PRICES (Annual, %)			GDP PER CAPITA, PPP (Constant 2017 International US$)			GDP PER PERSON EMPLOYED, PPP (Constant 2017 PPP $)		
	2015	2018	2019	2015	2018	2019	2015	2018	2019
Cambodia	1.22	2.46	--	3,543.7	4,159.3	4,388.8	6,475.22	7,401.84	7,791.16
China	1.44	1.59	2.07	12,691.9	15,243.3	16,116.7	23,257.92	28,308.76	30,142.61
Indonesia	6.36	3.20	3.03	10,149.6	11,371.5	11,812.2	22,033.57	24,013.55	24,884.53
Japan	0.79	0.98	0.48	39,672.95	41,074.10	41,429.29	78,682.16	77,897.37	78,570.28
Korea, RO	0.71	1.48	0.38	38,870.12	41,894.11	42,661.17	74,731.69	79,529.80	81,005.55
Lao, PDR	1.28	2.04	3.32	6,543.66	7,592.82	7,826.39	12,646.72	14,458.19	14,825.10
Malaysia	2.10	0.88	0.66	24,787.83	27,557.65	28,364.49	52,993.97	58,445.37	59,809.02
Philippines	0.67	5.21	2.48	7,186.77	8,717.05	9,277.37	17,877.01	21,201.68	21,963.13
Singapore	-0.52	0.44	0.57	89,366.31	97,744.96	97,341.47	148,939.77	164,357.49	164,153.71
Thailand	-0.90	1.06	0.71	16,301.54	18,086.51	18,463.09	28,956.02	32,523.01	33,220.84
Timor-Leste	0.55	2.64	--	3,302.72	3,079.90	3,123.11	8,579.31	7,689.89	7,748.60
Viet Nam	0.63	3.54	2.80	6,438.26	7,586.39	8,041.18	10,933.14	12,993.74	13,799.51

Note: ILO - International Labor Organisation; PPP - purchasing power parity
Source: World Bank, 2021.

Japan, RO Korea, and China are among the largest manufacturers of consumer technology globally, while Hong Kong SAR, China, and Singapore are widely recognized as leading worldwide financial centers. Manufacturing has fueled the high-tech engines of the EAS economies, which have recently taken advantage of the massive labor pool.

Southeast Asia is currently seeing rapid economic growth and development, combined with increasing populations and urbanization. As shown in **Figure 2.4**, the GDP of the countries in Southeast Asia reached US$ 3.1 trillion in 2019 – more than triple what it was in 2005. The regional economy is growing at more than four percent per year, among the highest rates in the world, with considerable variation between countries. Countries are also undergoing structural transformations, moving from agriculture to extractive industries, manufacturing and services in different ways and at varying speeds. Backed by a strong influx of foreign direct investments, some countries have emerged as hubs for a wide variety of industries and services. However, this impressive growth trajectory raises acute concerns about environmental sustainability, and improving inclusion and access to basic services.

Figure 2.4: Gross Domestic Product In 2019 (In Constant Prices).



Source of data: World Bank, 2021.

The cash economy has become a major driving force as people desired living standards and lifestyles comparable to developed nations. The high-performing economies in the EAS region have the following common features: demographic transition, dynamic agricultural sector, rapid growth of exports, high investment rates, and high investment in human capital development. Rapid modernization, along with a focus in innovative technology, has allowed the region to achieve rapid economic growth.

Because income is such an important influence on consumption of almost all goods and services, increasing prosperity will present major challenges for the ocean environment, fisheries, and other marine resources. The massive growth of the region and cities over the past 40 years has significantly affected the environment, with fallout felt from the local to the national levels, and even across borders. Investments in digital and 'green' infrastructure and technologies, habitat restoration, and climate proofing can provide new sources of growth, support jobs and livelihoods, while ensuring sustainability and resiliency. Strengthening of local government involvement in disaster resilience initiatives to address environmental and climate risks is also vital. There is a need to raise the policy focus on several measures as part of macroeconomic development plans: flood-risk integrated water resources management; construction of disaster-resilient multipurpose evacuation and community centers; mangrove afforestation to protect shorelines from storms, floods, and coastal erosion; hydroponics projects that could generate incomes during normal times and maintain food security when disaster occurs; and conservation of coral reefs to ensure shoreline protection, and food security from fisheries, among other ecosystem services.[11] Governments at all levels must be committed to environmental sustainability, social inclusiveness, wellbeing, and improved quality of life for all, rather than economic growth and efficiency alone.

2.2.3 Human Development

Human development puts people at the centre of development—people are agents of change. The Human Development Index (HDI) is a summary measure for assessing long-term progress in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living.[12] A long and healthy life is measured by life expectancy. Knowledge level is measured by (a) mean years of schooling among the adult population, which is the average number of years of schooling received in a lifetime by people aged 25 years and older; and (b) access to learning and knowledge by expected years of schooling for children of school-entry age, which is the total number of years of schooling a child of school-entry age can expect to receive if prevailing patterns of age-specific enrolment rates stay the same throughout the child's life (UNDP, 2019). Standard of living is measured by Gross National Income (GNI) per capita expressed in constant 2011 international dollars converted using purchasing power parity (PPP) conversion rates. **Tables 2.3** and **2.4** present the data for HDI and HDI components in the EAS countries.

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11 OECD. 2020a, p.7.
12 UNDP, 2019.

Singapore, Japan, RO Korea, and Malaysia are in the *very high* human development category. Thailand, China, Indonesia, Viet Nam, and the Philippines have *high* human development, while Cambodia, Lao PDR, and Timor-Leste are in the *medium* category.

Table 2.3: Human Development Index (HDI).

Country	HDI in 2015	HDI in 2018	HDI in 2019	Human Development Category
Cambodia	0.570	0.585	0.594	Medium
China	0.739	0.755	0.761	High
Indonesia	0.695	0.712	0.718	High
Japan	0.908	0.917	0.919	Very High
Korea, RO	0.907	0.914	0.916	Very High
Lao PDR	0.598	0.609	0.613	Medium
Malaysia	0.796	0.805	0.810	Very High
Philippines	0.701	0.711	0.718	High
Singapore	0.931	0.936	0.938	Very High
Thailand	0.749	0.772	0.777	High
Timor-Leste	0.610	0.599	0.606	Medium
Viet Nam	0.688	0.700	0.704	High

Source: UNDP, 2020.

Table 2.4: Human Development Index (HDI) Components.

COUNTRY	Life Expectancy at Birth (Years)		Expected Years of Schooling		Mean Years Of Schooling		Gross National Income (GNI) Per Capita (US$, 2011 PPP Prices)	
	SDG 3		SDG 4.3		SDG 4.3		SDG 8.1, 8.5	
	2015	2019	2015	2019	2015	2019	2015	2019
Cambodia	68.6	69.8	11.2	11.5	4.7	5.0	3,332	4,246
China	75.9	76.9	13.8	14.0	7.7	8.1	12,644	16,057
Indonesia	70.8	71.7	12.9	13.6	7.9	8.2	9,815	11,459
Japan	83.9	84.6	15.2	15.2	12.5	12.9	41,194	42,932
Korea, RO	82.1	83.0	16.6	16.5	12.1	12.2	38,990	43,044
Lao, PDR	66.5	67.9	11.1	11.0	5.1	5.3	6,253	7,413
Malaysia	75.5	76.2	13.5	13.7	10.2	10.4	24,118	27,534
Philippines	70.6	71.2	12.8	13.1	9.3	9.4	8,114	9,778
Singapore	82.9	83.6	16.1	16.4	11.6	11.6	83,499	88,155
Thailand	76.1	77.2	13.9	15.0	7.6	7.9	15,469	17,781
Timor-Leste	68.5	69.5	12.5	12.6	4.5	4.8	5,753	4,440
Viet Nam	75.1	75.4	12.7	12.7	8.0	8.3	6,130	7,433

Source: UNDP, 2020.

Life expectancy at birth in the region is 69 years old and above. Japan and RO Korea have the highest life expectancy in the region. The indicators on schooling illustrate the achievement (stock) and the expected addition (flow) of qualified human resources in the countries. However, differences between the mean years schooling, and expected years of schooling show that more efforts are needed to improve access to learning and knowledge.

The HDI components are indicators of drivers influencing economic activities that could create pressures on ocean health and resource uses and effective ocean management. Based on the environmental Kuznets curve,[13] it is possible that economic growth combined with improved human development, higher disposable income, increasing awareness and improving education levels will be compatible with an improved environment. However, it requires a very deliberate set of policies, incentives, and awareness to affect behaviour change and willingness to conserve natural resources, reduce waste, and produce goods sustainably or in the most environment- and climate-friendly way.

2.2.4 Human Capital

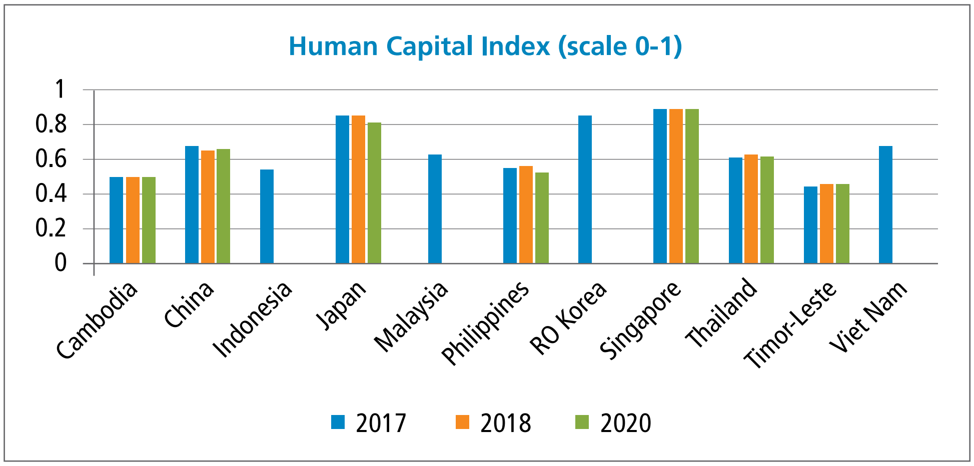
Human capital is the economic value of the qualities of labor that influence productivity. It represents a form of wealth available to nations and organizations to accomplish their goals. Human capital is the stock of habits, knowledge, and social and personality attributes (including creativity) embodied in the ability to perform labor so as to produce economic value. It includes intangible collective resources or assets like education, training, intelligence, talents, experience, skills, health, judgment and wisdom possessed individually and collectively.

The **Human Capital Index (HCI)** links selected human capital outcomes with productivity and income levels. It is a forward-looking measure of how current health and education outcomes (including a new measure of learning-adjusted years of school) will shape productivity for the next generation of workers. Japan, RO Korea, and Singapore have the highest HCI scores in the region.

Korean students
(Photo by M. Ebarvia)

[13] The environmental Kuznets' curve theorizes that environmental damage is low in the initial stages of development, rises with rapid industrialization, and then falls again as economies mature and human development improves.

Figure 2.5: Human Capital Index.



Source: World Bank, 2021.

2.2.5 Poverty and Living Conditions

The region has also made strides over the past decades on several socioeconomic indicators. As national incomes have been increasing in the region, poverty incidence has been declining. Based on the US$ 1.25 purchasing power parity (PPP) per day threshold, the poverty rate has fallen except in Lao PDR and Timor-Leste. Viet Nam has achieved the fastest reductions. However, at US$5.50 PPP per day, around half of the population in Indonesia and the Philippines, and a quarter of the population in China and Viet Nam would fall below the poverty threshold. **Table 2.5** shows the poverty headcount ratio in the EAS countries.

Table 2.5: Povery Indicators.

Country	Poverty Headcount Ratio (2011 PPP) (% of population)			Poverty Headcount Ratio (% of population)
	At $1.90/Day	At $3.20/Day	At $5.50/Day	At National Poverty Lines
Cambodia				17.7 (2012)
China	0.5 (2016)	5.4 (2016)	24.0 (2016)	0.6 (20190
Indonesia	3.6 (2018)	21.5 (2018)	53.2 (2018)	9.8 (2018)
Japan	0.7 (2013)	0.9 (2013)	1.2 (2013)	
Korea, RO	0.2 (2012)	0.5 (2012)	1.2 (2012)	
Lao PDR	21.2 (2012)	56.8 (2012)	84.4 (2012)	
Malaysia	0.1 (2011)	0.2 (2015)	2.7 (2015)	5.6 (2018)
Philippines	6.0 (2015)	25.8 (2015)	54.9 (2015)	
Singapore				
Thailand	0.1 (2012)	0.5 (2018)	8.4 (2018)	9.9 (2018)
Timor-Leste	30.4 (2014)	73.3 (2014)	94.0 (2014)	
Viet Nam	1.9 (2018)	6.8 (2018)	23.1 (2018)	6.7 (2018)

Source: World Bank, 2021.

Overcoming *environmental* degradation is necessary for *poverty reduction*. From an environmental perspective, poverty is often seen as a key driving force behind unsustainable environmental use. Yet, the poor are the most exposed to environmental changes and the most reliant on access to and availability of natural resources for their livelihood, resiliency, and coping strategies. Under sustainable development, the relationship between poverty and environmental change is described as a two-way interactive process. Poverty is viewed as both a cause of environmental degradation, and a result of people living in fragile and ecologically vulnerable environments. Poor households in rural areas face disproportionate losses from the depletion of natural capital due to their relatively high dependence on ecosystem services for income. It has been estimated that ecosystem services and other nonmarket goods account for around 47-89 percent of the so-called **GDP of the poor** (the effective GDP of total source of livelihood of rural and forest-dwelling poor households), whereas in national GDP, the agriculture, forestry and fisheries sector accounts for only 6-17 percent (TEEB, 2010).

In many developing countries, the high rate of urbanisation has not kept pace with the development and improvement in basic urban service delivery. Inadequate provision of water and sanitation services has an impact not only on human health, but also on the health of the environment, through pollution of waterways and coasts in particular. Contamination of the drinking water supply and inadequate sanitation facilities facilitate the spread of diseases like diarrhoea, typhoid, and cholera. Discharges of untreated wastewater to rivers and coasts have affected water resources—surface water, groundwater, and marine water quality—which have consequent effects on fisheries, coastal habitats, aquatic life, and opportunities for recreation and tourism.

Safely managed water supply, sanitation and hygiene, and wastewater management – explicit targets of the SDG 6 – are recognized as a top priority for improving health, nutrition, and productivity of people, and improving environmental and living conditions. Achieving SDG 6 will contribute to achieving SDG 14 (Target 14.1)[14] as well.

More than 90 percent of the people in the EAS region have access to *at least basic* drinking water services, except in Cambodia (78.5 percent), Indonesia (89 percent), Lao PDR (82 percent), and Timor-Leste (78 percent). Access to *safely managed* water services is high in Singapore (100 percent), Japan and RO Korea (98 percent), and Malaysia (93 percent).

In terms of *safely managed* sanitation services, 99-100 percent of the population in Japan, RO Korea, and Singapore have access to these services. Most of the EAS countries have high access to *at least basic* sanitation services, but more needs to be done in countries with low percentage of population with access, e.g., Cambodia (59.2 percent), and Timor-Leste (53.5 percent). Likewise,

[14] SDG 14 (Life Below Water) – Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

access to basic and safely managed sanitation services still needs to be improved in Indonesia, Lao PDR, and the Philippines. Data on access to safely managed sanitation services in Cambodia, Indonesia, Thailand, Timor-Leste, and Viet Nam are not available.

For other indicators of living conditions, there is a high percentage of the population with access to electricity. Energy consumption in Southeast Asia nearly doubled between 1995 and 2015, growing at an average pace of 3.4 percent annually.[15] This has fueled economic growth and permitted higher living standards. Renewable energy consumption accounts for 24 percent of the total final energy consumption of the EAS countries. Renewable energy use is higher in the developing countries in the region compared to the more developed countries due to large hydropower comprising over three quarters of the renewable generation mix in the former.

The value of clean water and renewable energy goes well beyond providing water and energy services. Fulfilling SDG 6 (on water) and SDG 7 (on energy) would also help countries meet other key goals, including the SDGs on poverty alleviation (SDG 1), food and nutrition (SDG 2), health (SDG 3), affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), climate action (SDG 13), life below water (SDG 14), and life on land (SDG 15).

Table 2.6: Living Conditions.

Country	Access to at least Basic Drinking Water Services (% of population)	Access to Safely Managed Drinking Water Services (% of population)	Access to at least Basic Sanitation Services (% of population)	Access to Safely Managed Sanitation Services (% of population)	Access To Electricity (% of population)	Renewable Energy Consumption (% of total final energy consumption)
	2017	2017	2017	2017	2018	2015
Cambodia	78.5	25.9	59.2	--	91.6	64.9
China	92.8	--	84.8	72.1	100.0	12.4
Indonesia	89.3	--	73.1	--	98.5	36.9
Japan	99.1	98.5	99.9	98.8	100.0	6.3
Korea, RO	99.8	98.2	100.0	99.9	100.0	2.7
Lao PDR	82.1	16.1	74.5	58.1	97.9	59.3
Malaysia	96.7	93.3	99.6	88.6	100.0	5.2
Philippines	93.6	46.7	76.5	51.6	94.9	27.5
Singapore	100.0	100.0	100.0	100.0	100.0	0.7
Thailand	99.9	--	98.8	--	100.0	22.9
Timor-Leste	78.3	--	53.5	--	85.6	18.2
Vietnam	94.7	--	83.5	--	100.0	35.0

Source: World Bank, 2021.

15 International Renewable Energy Agency (IRENA). 2018.

3 Our Ocean Wealth

"He who knows what sweets and virtues
Are in the ground, the plants, the waters, the heavens
And how to come at these enchantments--
is the rich and royal man."
- **Ralph Waldo Emerson**

Over recent years, much progress has been made towards getting a better understanding of the role of the natural environment in contributing to the economic performance of countries and wellbeing of individuals. Environmental assets – like other assets – provide benefits that enhance economic performance, offer new opportunities for investment and employment, and improve living standards and quality of life. However, just like other assets, enhancing or diminishing the condition of natural and environmental assets increases or reduces the stream of benefits that can be derived from them at present and in the future. The natural environment is currently being used in a non-sustainable way, as shown by its diminishing condition and impacts. Over the past decades, economic growth has come at the expense of the environment. Exploitation of the marine ecosystems brings with it an intertemporal choice. For example, there is a choice of catching the fish today, or restrain from fishing with the option of an increase in the benefit from future harvest. Intertemporal choices are decisions with consequences that play out over time.

Sustainability requires maintaining assets and opportunities so that future generations can also meet their needs. Opportunities are passed to future generations through a set of capital assets. Nature provides an important class of these assets, but markets seldom reveal the marginal value of natural capital. In particular, nonmarket ecosystem services, such as the climate regulation, shoreline protection, waste assimilation, etc., and environmental externalities are seldom measured and captured in the national income accounts. Thus, the benefits from natural assets and the trade-offs are not reflected properly in policy and project appraisal across government.[16]

To make informed choices and ensure sustainability of natural capital, it is of utmost importance to monitor and measure these natural assets. What gets monitored and measured, gets managed. We tend to value what we have measured, but there are so many goods and services provided by nature that are not measured. This has affected the choices we make as a society. **We need to measure what we value**.

[16] UK Department for Environment, Food and Rural Affairs. 2007.

The marine and coastal ecosystems should be regarded as a 'blue diamond' in recognition of their significant 'value' and are assets, which if invested properly, will return or repay dividends over time (**Box 3.1**). Such rare and exquisite treasures can be lost forever if management interventions and actions needed to protect them are not taken now. Knowing the economic worth of ecosystem services (in monetary terms) can help ensure that all of us see their value, and those who rely heavily on ecosystems – from fishers to governments, industries and businesses – can integrate restoration, conservation, and pollution reduction in their planning and use of the oceanic capital.

The development of ocean accounts enables decision makers to track whether economic activities and investments are building ocean wealth for future generations. Ocean accounts operate as a sustainable development scorecard for the ocean economy and ocean health. They can either be fully integrated into existing national accounting frameworks or developed as satellite accounts so that the long-term ocean health and wealth of a country can be independently and easily analyzed.

Box 3.1. Why Blue Diamond?

- The blue diamond relates to the marine and coastal environment as one which produces wealth in terms of food, jobs, trade, livelihoods, and ecosystem services like water recycling, climate regulation, and shoreline protection.
- A diamond is the strongest form of carbon: Key coastal habitats, such as mangrove forests, salt marshes, coral reefs and seagrass meadows provide an important and valuable sink capacity. According to UNEPs Blue Carbon Report, the improved management and restoration of the oceans blue carbon sinks would result in preventing an annual loss of approximately 10 percent of emission reductions we currently need. A diamond's strength also represents 'resilience' which is crucial for coastal communities to mitigate against the negative effects of climate change.
- A diamond also signifies 'rarity': the habitats above are being lost four times faster than our rainforests and the rate of loss is accelerating.
- A diamond has many sides i.e., it is 'multifaceted': This is because the marine and coastal environment is often the place where many interests meet, some interests related to land, some related to the sea. These 'interests' can be communities, fishers, tourists, NGOs, scientists, industry and services as well as local and national governments.
- A diamond has very strong atomic bonds: This represents strong bonds through cooperation and working together for those different interest goups and stakeholders that operate at the land-ocean interface. This could be developing bonds at the local, national, regional or international levels. A strong interlocking network of interest groups can significantly contribute to better management to the benefit of all stakeholders.
- Finally, a diamond has great beauty and is valued by all. The purity or clarity of the diamond increases its value. The same holds true for marine ecosystems and biodiversity.

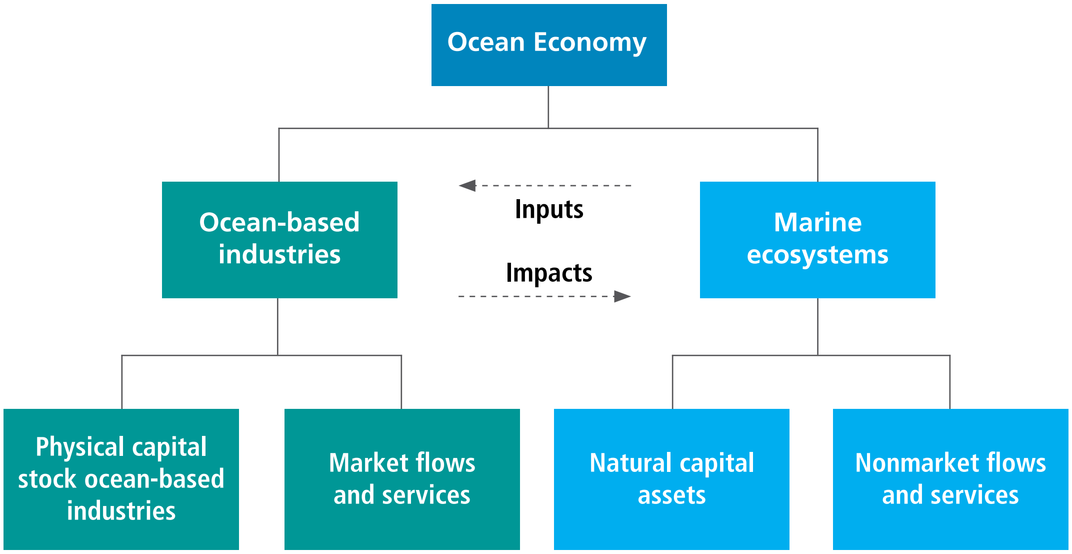
Source: http://www.gpa.unep.org/index.php?option=com_content&view=article&id=55&Itemid=41

3.1 Ocean Economy

Oceans provide an extensive range of natural assets and resources from which humans derive a wide variety of goods and ecosystem services that make life possible and upon which human activities rely on. There is increasing interest in the huge potential presented by the ocean economy but at the same time awareness and understanding of the role of ocean has been improving, with growing clamour to protect the world's ocean and seas in the face of the existential threats from climate change and biodiversity loss. Oceans are now recognised as essential for addressing many of the global challenges, from climate change to food security, poverty reduction, improved medical care, and provision of energy, water, and other natural resources, and its importance in world trade, logistics, travel, tourism, and leisure pursuits.

The entire ocean economy consists of: (a) ocean industry or economic activities with dependence on the ocean and coastal and marine resources, and (b) natural assets and goods and services provided by marine ecosystems (**Figure 3.1**). In many cases, marine ecosystems provide intermediate inputs to the ocean-based industries, while conversely, ocean industries can impact the health of marine ecosystems.[17]

Figure 3.1: Scope of the Ocean Economy.



Source: OECD, 2016.

[17] OECD, 2016.

The sectoral scope of the ocean economy varies considerably by country. Even the US and EU have conceptual and methodological differences (**Box 3.1**). Internationally agreed definitions and statistical terminology for ocean-based activities and the guidance and methodology for ocean (environment-economy) accounting, including the valuation of ecosystems services, are still being developed.

Currently, the ocean industry in the EAS countries is being measured using the System of National Accounts (SNA). The ocean industry includes:

- *ocean-based* activities, such as fisheries, marine tourism, marine transportation (shipping), offshore oil and gas, ocean energy and marine renewable energy, etc.
- *ocean-related* activities: (a) those that use products from the ocean (e.g., seafood processing, marine biotechnology, salt); (b) produce products and services for the ocean-based activities (e.g., ports, ship building and repair, manufacturing of marine equipment, communication, maritime insurance); (c) marine education and research; and (d) government agencies with direct maritime responsibilities (e.g., navy, coast guard, marine environmental protection).

Some of these are *established* industries like fishing, tourism, ports, shipping and shipbuilding, while others are called *emerging* industries (**Table 3.1**).

Table 3.1: Established and Emerging Ocean-Based Industries.

ESTABLISHED	EMERGING
Capture fisheries Coastal aquaculture Offshore oil and gas Seafood processing Shipbuilding and repair Marine manufacturing Marine construction and dredging Marine and coastal tourism Ports Shipping Marine business services Marine research and development (R&D) Marine education Maritime defense	Marine aquaculture (industrial scale) Oil and gas in deep- and ultra-deep water Offshore wind energy Marine renewable energy (ocean energy) Deep seabed mining Desalination Marine biotechnology Marine communications (submarine fiber optic cables) Maritime safety, ocean monitoring, and surveillance High-tech marine products and services

Source: modified from OECD, 2016.

The ocean also provides services that are not usually quantified and captured in the national income accounts, such as *regulating* services, *supporting* services, and *cultural* services (**Figure 3.4, p.49**). There is a need to measure and quantify these benefits and services to show that they are just as valuable as the physical capital, and the market goods and services would not have been produced by the ocean industries without these natural resources. Ecosystem services are classified along functional lines within the Millennium Ecosystem Assessment (MA), using categories of provisioning, regulating, cultural, and supporting services:

- *Provisioning services*: These are products obtained from the ecosystems (e.g., fish, seaweeds, etc.). They are direct use values and already included in the assessment of ocean economic activities.
- *Regulating services* (e.g., climate regulation, carbon sequestration, waste assimilation, shoreline protection, etc.): These are the benefits obtained from the regulation of ecosystem processes. These are also indirect use values.
- *Cultural services* (e.g., spiritual, traditional, recreational, and educational values): These are nonmaterial benefits of ecosystems. Only tourism and recreational activities are usually included in the 'measured' ocean economic activities and GDP. However, the consumer surplus from recreation is not included in the GDP. The value of many rare and endangered species consists of both recreational use and nonuse (existence and bequest) values, which can be measured by eliciting willingness-to-pay (WTP) for the preservation of a particular species. It has been found that people are willing to pay a small portion of their income towards the protection of endangered or rare species for a variety of reasons.
- *Supporting services* (e.g., primary production, production of atmospheric oxygen, nutrient cycling, water cycling, provisioning of habitat, nursery for fisheries etc.): These are the ecosystem benefits that are necessary for the production of all other ecosystem services. These are indirect use values of ecosystems, and their impacts on people occur over a very long period. As such, these are not usually included in the ocean economy assessment.

The *System of Environmental-Economic Accounting* (SEEA) is a tool for measuring the condition of the environment, the contribution of the environment to the economy, and the impact of the economy on the environment. In some countries, SEEA has been used to produce Forestry Accounts, Fisheries Accounts, Water Accounts, Land Accounts, Minerals Accounts, Greenhouse Gas (GHG) Emission Accounts, and Energy Accounts. However, ocean accounts have not been developed in many countries. The UN Economic and Social Commission for Asia and the Pacific (UNESCAP) is leading efforts on an Ocean Accounts Partnership to develop standards for ocean statistics based on the integrated approach of the SEEA.[18]

Through the development of the NSOC reports, countries in the EAS region have come to recognize the value of developing ocean accounts, especially their application in the development and implementation of ocean policies and plans and in monitoring their impacts to the economy and the ecosystems. Coastal and marine ecosystems are of increasing national, regional and global importance given their contribution to food, income, livelihood, trade, shoreline protection, blue

[18] United Nations, System of Environmental Economic Accounting. "Ocean Accounts Partnership holds first meeting." https://seea.un.org/news/ocean-accounts-partnership-holds-first-meeting.

carbon, and climate regulation among others. These ecosystems are showing rapid declines, which are expected to compromise—sometimes irreversibly—benefits and opportunities that the ocean provides to people.

Box 3.2. Ocean Economy Comparisons: United States (US) and European Union (EU)

The National Oceanic and Atmospheric Administration (NOAA) of the US made a report in 2019 on the Ocean and Great Lakes Economy, using 2016 data from the Economics: National Ocean Watch (ENOW) of NOAA. The 2020 EU Blue Economy Report presents data from 2007 to 2018, and utilizes the data collected by the European Commission through the Member States and the European Statistical System. There are key methodological differences between these two reports.

First, the US includes the Great Lakes. Second, the US uses GDP at market prices whereas the EU uses GVA (at factor costs). Third, there are differences in the scope and sectors covered in the two reports. NOAA is under the Department of Commerce; hence, its report focuses on the employment, wages, number of establishments (enterprises), and GDP of six sectors—fisheries and aquaculture, shipbuilding, tourism and recreation, marine transportation, marine construction, and offshore oil and gas—what the EU considers as the *established* sectors. The EU acknowledges the need to ensure that all angles are taken into account, and considers that economic growth and employment go hand in hand with protecting and restoring nature and fighting climate change. The EU report tries to analyze all sectors related to the ocean economy, and therefore includes the *emerging* sectors and ecosystem services in addition to the established sectors. Fourth, the EU report also includes challenges like marine pollution and climate change as well as enabling conditions for blue economy, such as key policy instruments, marine spatial planning (MSP), and financing and investment mechanisms.

The comparison of sectors included in the NOAA report and EU report is as follows:
- **Living resources:** fisheries and aquaculture – included in both reports.
- **Ship and Boat Building and Repair:** The EU includes machinery/equipment in this sector whereas the US includes machinery/equipment under marine transportation sector.
- **Tourism and recreation:** The US does not include tourism-related transport but the EU does.
- **Marine Transportation:** For the EU, ports and shipping are two separate sectors; machinery/equipment is under Shipbuilding; and warehousing is under the Port sector. The US does not have a separate Port sector, and machinery/equipment and warehousing are included under the Marine Transportation sector.
- **Marine construction:** This sector is not presented as such in the EU Report; instead, the marine construction activities are split into other sectors or not included at all.

Box 3.2. Ocean Economy Comparisons: United States (US) and European Union (EU) (cont.)

- **Non-living resources:** Offshore oil and gas and mineral extraction is included in the ocean economy of the US. This sector has a high contribution to the GDP of the US compared to the EU.
- **Marine renewable energy:** EU considers offshore wind power as one of its seven established sectors. This sector is not included in the US/NOAA report.
- **Other emerging sectors:** The EU report includes analysis of emerging and innovative sectors, e.g., ocean energy, blue bioeconomy and biotechnology, desalination, marine minerals, submarine cables, and maritime defense.
- **Coastal and marine ecosystem services:** included in the EU Report, but not in the NOAA report.

Sources: European Commission, 2020; National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management, 2019.

3.2 The Ocean Industry in the EAS Region

In 2015, the ocean economy as reported by ten countries in their SOC reports was estimated to be worth around **$1.5 trillion** in value added (**Table 3.2**). These are conservative estimates because several important activities in the ocean economy are not captured due to lack of data.

The ocean economy in the EAS region contributes to the gross domestic product (GDP) or national economy of the countries in varying degrees: from three percent in RO Korea to 87 percent in Timor-Leste (**Figure 3.2**). At least **61 million** people in the EAS Region are employed in the ocean industries (**Figure 3.3**).

Note that the ocean accounting in the EAS region is a work in progress, and the estimates in this report are not meant to be a comparative analysis among the countries. There are still major gaps and concerns in the ocean industry accounts: lack of classification and disaggregated data for the ocean-based and -related industries; small input-output (I-O) tables; lack of gender-disaggregated data; use of constant prices and the price index and base year to be applied; conversion from local currency to US dollar; use of purchasing power parity (PPP); etc. The statistical agencies in most of the countries need to get on board for the development of the ocean industry accounts. The UN and other international organizations can provide technical assistance for capacity building and knowledge sharing for the ocean accounts development.

For the coastal and marine ecosystem accounts, the major issues are: lack of regular monitoring of ecosystems/habitats (area, condition, uses), emissions to marine waters, and marine water quality;

and lack of studies on the valuation of coastal and marine ecosystem services, interconnectedness of coastal and marine ecosystems, and environmental damage assessment. More importantly, these ocean economic activities and ecosystem services must be **sustainable** to be considered as **blue** economy as defined by the EAS Region in the Changwon Declaration 2012.

Figure 3.2: Share of Ocean Economy in GDP.

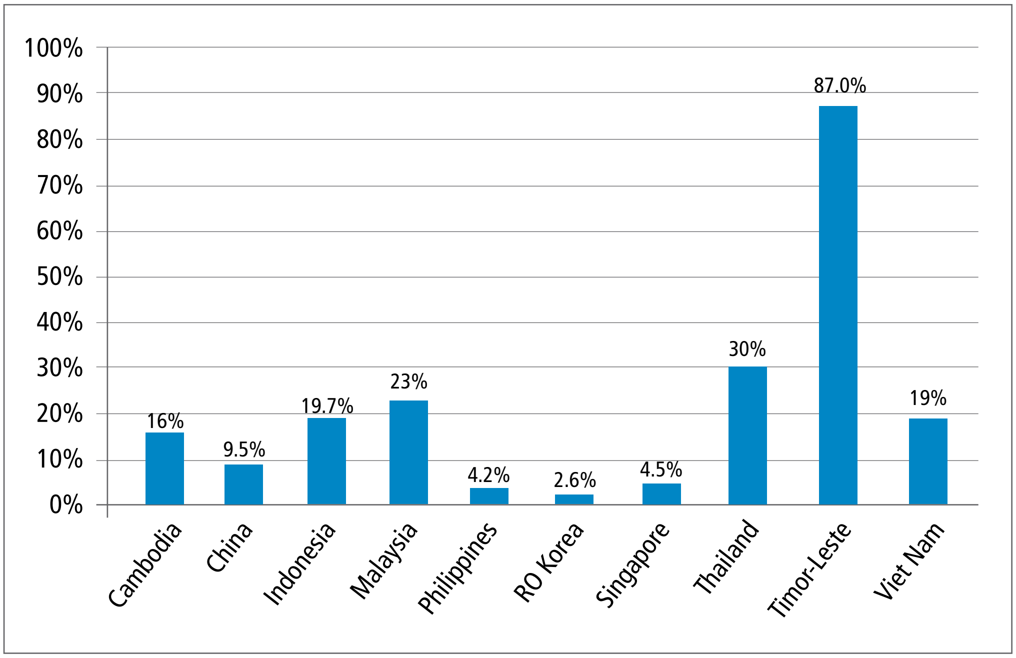
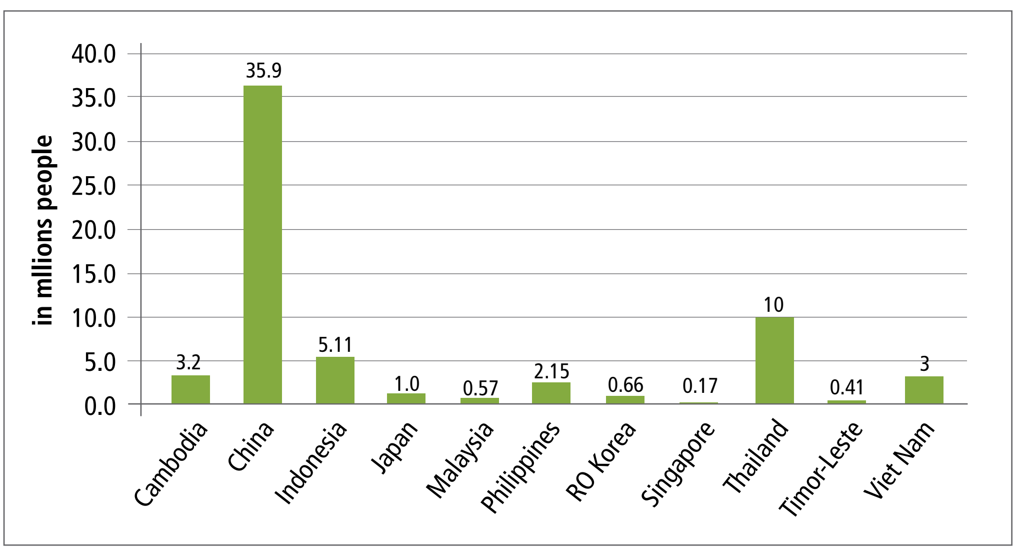


Figure 3.3: Employment in Ocean Economy.



Source: NSOC Reports and NSOC Briefs.

Table 3.2: Ocean Economy in the EAS Countries In 2015 (US$ Billion).

	Cambodia	Indonesia	PR China	Malaysia	Philippines
1. OCEAN ECONOMIC ACTIVITIES (gross value added, Year 2015, in billion US$, in constant prices)					
Fisheries and Aquaculture	1.10	15.18	68.50	12.83	2.59
Offshore Oil and Gas		22.76	15.58	2.18	0.80
Mining (Minerals)			1.01		
Energy/electric supply (ocean energy; offshore wind, renewables)			1.91		1.22
Water (seawater utilization; desalination)			0.22		
Manufacturing		40.06	43.58	0.88	1.99[d]
• Seafood processing					
• Ship building and repair					
• Marine transport equipment					
• Marine biotechnology, pharmaceuticals, chemicals					
Marine Construction		65.30	32.91	0.08	0.12
Shipping and Ports	1.21	2.24	89.54	23.73	1.38
• Marine transportation (shipping)					
• Ports, storage and warehouses					
Marine tourism and recreation	0.07	19.93	172.63	16.25	3.06
Government (navy, coast guard, etc.)		22.99			0.41
Marine research and education			202.47	5.43	0.04
Marine services					0.2[e]
Other ocean-related industries			413.55[b]		
TOTAL (billion US$)	**2.39**	**188.46**	**1,041.90**	**61.38**	**11.81**
2. CONTRIBUTION TO GDP (percent)	16.0%	19.7%	9.5%[c]	23.0%	4.2%
3. EMPLOYMENT IN OCEAN ECONOMY (million)	3.2	5.11[a]	35.86	0.57	2.15

Notes:
[a] For year 2013
[b] Includes ocean-related products and material manufacturing; ocean-related construction; marine wholesale and retail trade; ocean-related services
[c] Share of gross ocean product (core ocean product plus other ocean-related industries) to GDP
[d] Includes fish and seafood processing; shipbuilding and repair; manufacturing of engines and turbines for marine propulsion, pulleys, etc.
[e] Includes related maritime real estate, renting and business activities; financial intermediation; maritime insurance

Source: ***Cambodia:*** *NSOC of Cambodia 2018;* ***Indonesia:*** *NSOC of Indonesia 2018; Fahrudin 2017;* ***PR China:*** *NSOC of China 2018 (unpublished); China Marine Statistical Yearbook 2016; Zhu 2017;* ***Malaysia:*** *NSOC of Malaysia 2018 (unpublished); Kaur 2017;* ***Philippines:*** *NSOC of the Philippines 2018; Philippine Statistics Authority 2017.*

Table 3.2: Ocean Economy in the EAS Countries In 2015 (US$ Billion). (cont.)

	RO Korea	Singapore	Thailand	Timor-Leste	Viet Nam[k]
1. OCEAN ECONOMIC ACTIVITIES (gross value added, Year 2015, in billion US$, in constant prices)					
Fisheries and Aquaculture	6.90[f]		8.33	0.01	3.701
Offshore Oil and Gas			10.08	1.5	12.089
Mining (Minerals)			10.08		
Energy/electric supply (ocean energy; offshore wind, renewables)			5.50		
Water (seawater utilization; desalination)			5.50		
Manufacturing			49.45		
• Seafood processing					3.192
• Ship building and repair	6.90				2.032
• Marine transport equipment	1.50				
• Marine biotechnology, pharmaceuticals, chemicals • Offshore oil and gas processing					0.34
Marine Construction			3.07		
Shipping and Ports			10.42	0.07	1.816
• Marine transportation (shipping)	5.22				
• Ports, storage and warehouses	2.48				
Marine tourism and recreation			5.83[h]	0.02	5.455
Government (navy, coast guard, etc.)			3.92	0.38	0.18[l]
Marine research and education			3.39		0.013
Marine services	10.25		24.03[i]		0.46
Others	1.33[g]				
TOTAL (billion US$)	**34.57**		**118.19**	**1.97**	**29.28**
2. CONTRIBUTION TO GDP (percent)	2.6%	4.5%	29.6%	87%	18.9%
3. EMPLOYMENT IN OCEAN ECONOMY (million)	0.681		9.97[j]	0.41	3.0

Notes:

[f] includes marine fisheries and aquaculture production, fish and seafood processing, and fish distribution

[g] includes marine tourism and recreation; marine resource development and construction

[h] hotels and restaurants in coastal areas

[i] includes wholesale and retail trade; repair of motor vehicles and household goods ($13.89B); financial intermediation (US$4.16B); real estate, renting and business activities (US$5.13B), other community, social and personal services (US$0.74B), and private households with employed persons (US$0.11B)

[j] employment in 23 coastal provinces

[k] initial estimates from MPI (2015)

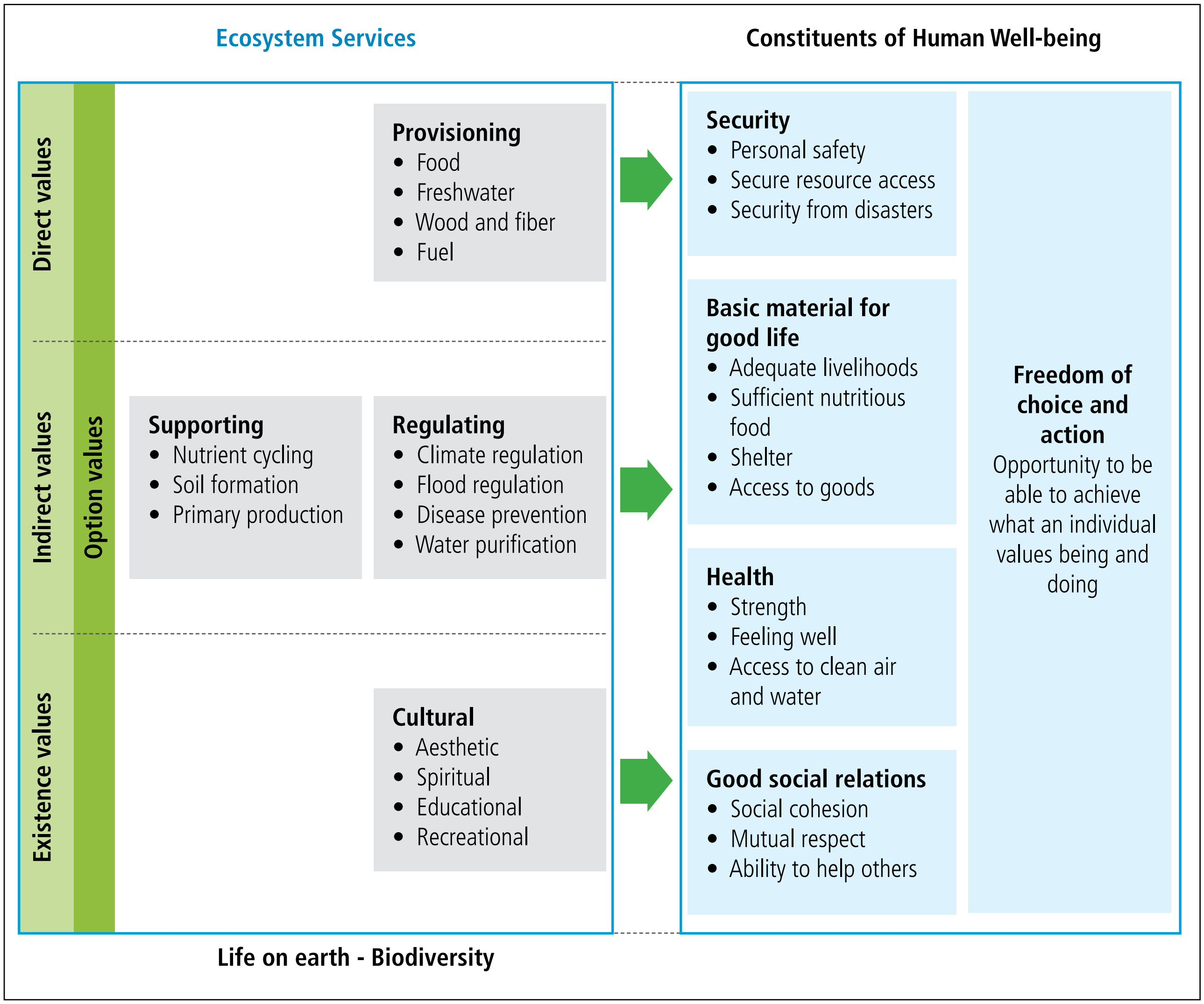
[l] search and rescue services

Source: ***RO Korea:*** *J. Chang 2021;* ***Singapore:*** *NSOC of Singapore 2018;* ***Thailand:*** *NSOC of Thailand 2018; Office of the National Economic and Social Development Board 2017; National Statistics Office of Thailand 2017;* ***Timor-Leste:*** *NSOC of Timor-Leste 2018;* ***Viet Nam:*** *Nguyen Hoang Ha (MPI) 2015.*

3.3 Natural Capital and Ecosystem Services: Measuring What We Value

There are ocean processes that influence climate and biodiversity and affect sustainability of ocean activities. There are also goods and services provided by healthy ocean and coastal and marine ecosystems that are not usually quantified. For example, scientists have estimated that the oceans produce half to two-thirds of all oxygen on Earth. This production is heavily influenced by oceanic plankton, including drifting plants, algae, and some bacteria that are able to photosynthesize. Healthy coastal habitats are not only important for seafood and recreation, but as carbon sinks, they also play an essential role in mitigating climate change. Likewise, these habitats function as natural barriers and contribute to adaptation by reducing vulnerabilities to impacts of climate change. **Figure 3.4** shows the different ecosystem services, and their contribution to improving human well-being.

Figure 3.4: Ecosystem Services.



Source: UNEP. 2010. The Economics of Ecosystems and Biodiversity (TEEB).

It should be pointed out that there are some provisioning services that are not included in the valuation of ecosystem services. Shipping, ocean energy, and the extraction of crude oil or other mineral resources also produce a value. However, these services are not derived from the living, functioning ecosystem, but just happens to be derived from the same spatial area. Nevertheless, they are part of the ocean resources and services. Considering that the ocean provides the means of transport of 80 percent of global trade, this service and its contribution to the markets and employment in the fast-growing economies of the EAS region must be included in the analysis of ocean value. Moreover, oil and gas are natural resources from the ocean, and as the offshore oil and gas industry has emerged as a major industry, it is included in the ocean economy. Indonesia, Malaysia, Thailand, Brunei, Viet Nam, Cambodia and Timor-Leste benefit from the rich energy resources available in their continental shelf. On the other hand, the impacts of oil and gas industry have to be taken into account while phasing out of fossil fuel use, and focusing on renewable energy's potential have to be emphasized under the blue economy paradigm.

Theoretically, valuation of ecosystem services involves estimating only those goods and services that come from the existence of a healthy ecosystem. However, due to time and budget constraints, the NSOC reports presented the results of available studies wherein the value of ecosystem services is based on the **use** (direct and indirect) and **non-use** values of existing ecosystems (**Figure 3.4**), regardless of their current condition or quality, or estimated using the benefit-transfer method.[19] The figures are quite significant, indicating that the wealth of countries could be even higher if these ecosystems are restored and protected, and if the non-market values of ecosystem services have been captured and added to the ocean economy and GDP of countries. These show the importance of natural capital and ecosystem service accounting, and how highlighting such values in discussions could lead to more informed decisions on growth and development strategies.

A move away from current economic thinking should include the benefits provided by mangroves, seagrass, coral reefs and other coastal ecosystems that are currently not accounted for in mainstream business and finance. Therefore, sustaining and restoring these ecosystems should be treated as an asset, and long-term investments should be made for their preservation. (**Section 13.1.4** shows the financial returns and benefits to be made from investing in the protection of coral reefs.)

- **Malaysia.** Coral reef-related businesses in Malaysia are worth approximately US$ 635 million annually in food, fisheries, tourism, and pharmaceuticals.

[19] The benefit transfer method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.

- **RO Korea.** Tidal flats, beaches, natural parks, estuaries and coastal waters in RO Korea generate annual benefits amounting to US$ 40.5-42.5 billion. Regulating, supporting, and cultural values of beaches and tidal flats contribute 78 percent of this amount.

- **Thailand.** The total economic value of coastal and marine resources in Thailand is around US$ 27.67 billion. Almost 37 percent of the value of ecosystems and selected endangered species came from indirect use and non-use values. Direct use referred to fisheries and tourism. Indirect use values are the ecosystem support to coastal fisheries, and provision of coastal protection, carbon sink, and nutrients. The valuation of endangered species is based on studies that estimated the existence value, using the contingent valuation method to determine the cost of conservation that people are willing to pay or accept.

Table 3.3: Value of Ecosystem Services (US$)

Country	Value of Ecosystem Services (US$)
Cambodia	200.42 million to 583.42 million
Indonesia	403 billion to 411 billion
Malaysia	17.7 billion
Philippines	1.5 trillion
RO Korea	40.5 billion - 42.6 billion
Thailand	36 B
Timor-Leste	5.25 B
Viet Nam	3.9 billion

Sources: NSOC Reports.

Box 3.3. Valuation of Ecosystem Services to Aid Policy and Finance Nature Conservation

Four case studies were highlighted in The Economics of Ecosystems and Biodiversity for Southeast Asia (ASEAN TEEB) Scoping Study: mangroves and coral reefs at the Southeast Asian regional level, forests at the provincial level, and an MPA at the local level. The scoping study emphasized how information on the economic value of ecosystem services can be used as a tool to influence policy-making processes and design instruments to finance conservation.

Box 3.3. Valuation Of Ecosystem Services To Aid Policy And Finance Nature Conservation (cont.)

- Southeast Asia is expected to lose one third of mangroves between 2000 and 2050 under a 'business-as-usual' scenario and estimated the reduction in the value of two ecosystem services: coastal protection and habitat/nursery support for fisheries. The value of loss of mangroves was estimated at **US$ 2 billion** (annual value in 2050).
- For the coral reefs, the value of lost reef-related fisheries in Southeast Asia is **US$ 5.6 billion** (annual value in 2050), with the highest loss in Indonesia and the Philippines.
- The case study on the Leuser forest ecosystem in Sumatra, Indonesia highlights the distribution of ecosystem service benefits across different stakeholders and possible outcomes of the the tradeoff between short term gains for some versus larger long-term losses for most.
- The case study on the Hon Mun marine protected area (MPA) in Viet Nam illustrates the potential impact of information on the economic values of ecosystem services to improve decision-making regarding nature conservation and finance. Based on the valuation studies on the MPA, the recommendation to introduce a user fee that is earmarked for use by the MPA has been adopted and the MPA is now partially self-financed.

Sources: Brander and Eppink, 2015.

3.3.1 Blue Carbon

Importance of blue carbon[20]

Salt marshes, mangroves, and seagrass beds have an important role in climate change mitigation. The carbon sequestered in these vegetated coastal habitats has been termed "blue carbon". They absorb large quantities of the carbon dioxide (CO_2) from the atmosphere and store it, thus decreasing the effects of global warming. These types of habitat are known as carbon sinks and contain large stores of carbon accumulated over hundreds to thousands of years.

These habitats play two important roles:

- **Carbon sequestration**—the process of capturing carbon dioxide from the atmosphere, measured as a rate of carbon uptake per year
- **Carbon storage**—the long-term confinement of carbon in plant materials or sediment, measured as a total weight of carbon stored

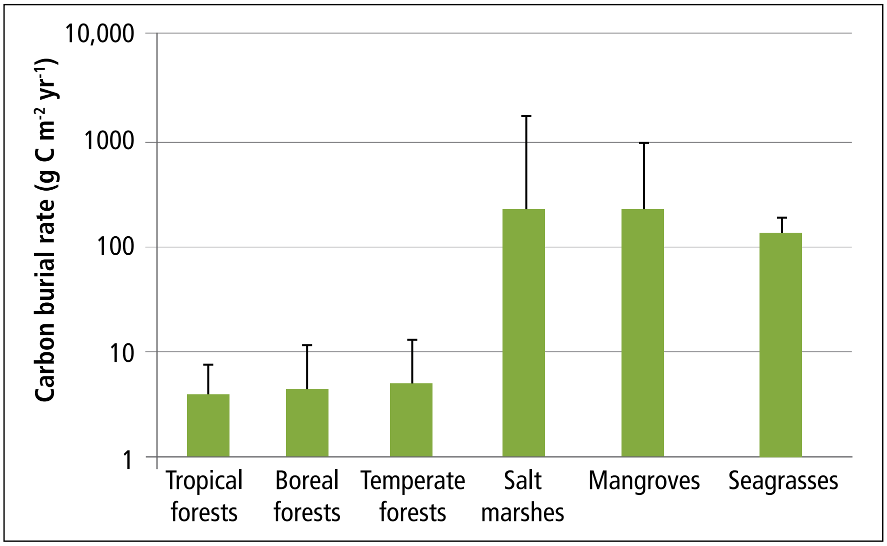
[20] The information in this section is from: National Oceanic and Atmospheric Administration (NOAA). Coastal Blue Carbon. (http://www.habitat.noaa.gov/coastalbluecarbon.html).

Although their global area is one to two orders of magnitude smaller than that of terrestrial forests, the contribution of vegetated coastal habitats per unit area to long-term carbon sequestration is much greater, in part because of their efficiency in trapping suspended matter and associated organic carbon during tidal inundation. Current studies suggest that mangroves and coastal wetlands annually sequester carbon at a rate ten times greater than mature tropical forests, and store three to five times more carbon per equivalent area than tropical forests[21] (**Figure 3.5**). This is because terrestrial forests store most of their carbon in their biomass (branches, roots, and leaves), while blue carbon ecosystems also store carbon in their biomass, and in addition, **store most of their carbon in their soils** (**Table 3.4**). Wet coastal soils have much lower oxygen levels than those on the forest floor, which causes dead plant matter to take a longer time to decay. As a result, the carbon stored in coastal soils can remain trapped there for thousands of years.

Challenges and opportunities

Ocean ecosystems serve as the largest carbon sink in the world. They are available, effective, and cost-efficient **nature-based solutions** (NBS) that can contribute to the mitigation required to keep global warming well below 2°C. Despite this potential, only a few countries include these coastal and ocean ecosystems in their national GHG inventories and Nationally Determined Contributions (NDC) targets. Although the Paris Climate Agreement recognizes REDD+[22] and the central role of forests in Article 5, this mechanism only relies on the carbon within the living biomass, which represents only a small portion of the blue carbon ecosystem potential.[23] The inclusion of sediment carbon storage can significantly increase natural ways to climate change mitigation.[24]

Figure 3.5: Carbon Storage Abilities of Different Habitat Types.



Mean long-term rates of C sequestration (g C m–2 yr–1) in soils in terrestrial forests and sediments in vegetated coastal ecosystems. Error bars indicate maximum rates of accumulation. Note the logarithmic scale of the y axis.
(Source: Mcleod et al. 2011.)

[21] https://oceanservice.noaa.gov/ecosystems/coastal-blue-carbon/

[22] REDD+: Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks. REDD+ is a UN-backed framework that aims to curb climate change by stopping the destruction of forests.

[23] Murray *et al*. 2011.

[24] Bossio *et al*. 2020.

Table 3.4: Mean, Range, and Maximum (in Brackets) Estimates of Areas Covered by Blue Carbon Sinks and Annual Organic Carbon Burial Rates.

Component	Area (million km^2)	Organic Carbon burial	
		tonne C ha^{-1} y^{-1}	Tg C y^{-1}
Vegetated habitats			
Mangroves	0.17 (0.3)	1.39, 0.20 – 6.54 (1.89)	17 – 23.6 (57)
Salt marsh	0.4 (0.8)	1.51, 0.18 – 17.3 (2.37)	60.4 – 70 (190)
Seagrass	0.33 (0.6)	0.83, 0.56 – 1.82 (1.37)	27.4 – 44 (82)
Total vegetated habitats	**0.9 (1.7)**	**1.23, 0.18 – 17.3 (1.93)**	**114 – 131 (329)**
Depositional areas			
Estuaries	1.8	0.5	81.0
Shelf	26.6	0.2	45.2
Total depositional areas			**126.2**
Total coastal burial			**237.6 (454)**
% vegetated habitats			46.89 (0.72)
Deep sea burial	330.0	0.00018	**6.0**
Total oceanic burial			**243.62 (460)**
% vegetated habitats			45.73 (0.71)

Source: Nellemann et al. 2009.

For mangrove forests, seagrass beds and salt marshes to be included in climate mitigation efforts, knowledge of the spatial distribution of soil carbon stocks of these coastal ecosystems are critical. Although global carbon sequestration rates are high for vegetated coastal ecosystems, these rates vary among locations, reflecting the wide array of factors that influence the magnitude of any given carbon sink.[25] Such factors include primary productivity, respiration, exchange of carbon with adjacent systems, hydrology, sedimentation rate, changes in nutrient cycles, changes in temperature, changes in sea level, location along tidal gradients, and species composition.[26] Current global and national estimates do not capture enough of the finer scale variability that would be required to inform local decisions on siting and designing protection and restoration projects, payment-for-ecosystem services (PES) projects, carbon market, and other conservation strategies. This calls for more site-specific studies that would be more useful for implementing restoration and conservation projects at the local level. Meanwhile, national ocean resource and ecosystem service accounting would be useful for macroeconomic and development planning and assessing the tradeoffs, such as with infrastructure and energy strategies. The ocean accounts should include the ocean industry accounts, fisheries accounts, mangrove forest accounts, coral reef accounts, as well as other habitat/resource accounts where possible.

[25] Mcleod *et al*. 2011.
[26] Middleton and McKee, 2001; Kristensen *et al*. 2008.

Ticking carbon bomb

Coastal habitats are important for capturing carbon—but their destruction poses a great risk. When these habitats are damaged or destroyed, it is not only their carbon sequestration capacity that is lost. If blue carbon stocks are disturbed, the carbon stored in the habitats is also released. The resultant gas emissions may be very high, thus, increasing the levels of GHG in the atmosphere. Unfortunately, coastal habitats around the world are being lost at a rapid rate, largely due to coastal development for housing, ports, commercial facilities, and aquaculture farms. Halting their destruction is a cost-effective action that has a clear impact in reducing global GHG emissions.

Considering that the Paris Agreement is based on NDCs, blue carbon may contribute to climate change mitigation at this scale. Mangrove forests, seagrass beds, and salt marshes are prime ecosystems for restoration and conservation, irrespective of uncertainties and the unique nature of implementing **REDD+** and **Blue Carbon** projects. Halting the loss of these coastal ecosystems and restoration of lost habitats will not solve climate change alone, but for many nations, including most small island nations, their protection and restoration represent one of the most viable climate change mitigation options.[27]

Economic Value of Blue Carbon

The concept of blue carbon was introduced in 2009 to show that the role of coastal ecosystems in absorbing carbon to reduce emissions is of global significance, and they should therefore be protected and restored (**Table 3.4**). A detailed assessment on carbon sequestration of tidal salt marshes, mangroves, seagrass meadows, kelp forests, and coral reefs have been done by the International Union for the Conservation of Nature or IUCN (Laffoley and Grimsditch, eds. 2009). Since the publication of these seminal publications, there have been a number of blue carbon studies that have been published. Alongi (2020) reviewed these various studies, and using the most recent data, showed the range of rates of C stocks, C sequestration, and potential and actual losses from deforestation.

For carbon stock, the total mangrove ecosystem C_{org} stocks average 738.9 Mg C_{org} ha^{-1} ± 27.9 Mg C_{org} ha^{-1} (±1 SE) with 224 measurements, and a median value of 702.5 Mg C_{org} ha^{-1} (Alongi, 2020).

Using the *mean* value of 738.9 Mg C_{org} ha–1, and the EAS mangrove area of 4,606,200 ha (**Table 13.1**), the C stock is estimated to be 3,403,521,180 tonnes-C. At the international carbon price of $10 per tonne CO_2 equivalent (tCO_2e),[28] the blue carbon stock of mangroves in the EAS region is worth **US$ 34 billion**. As of end of 2020, the weighted carbon price is around $20 per tCO_2e (World Bank, 2021n), and using this price, the blue carbon stock of the EAS mangroves could be worth **US$68 billion**.

Rates of carbon sequestration, derived from soil accretion rates, in mangroves average 179.6 g C_{org} $m^{-2}{\bullet}a^{-1}$ and a median of 103 g C_{org} $m^{-2}{\bullet}a^{-1}$ (Alongi, 2020). Using the EAS mangrove area of 4,606,200

[27] Sanderman, *et al*. 2018.
[28] Nurdianto and Resosudarmo, 2016.

ha, and multiplying by the mean value, carbon sequestration in the region's mangrove forests equates to 8,272,735.20 tCO_2e per year. This will have a value of **US$ 82.7 million per year** at US$10 per tCO_2e, and it increases to **US$165.5 million per year** using the carbon price of US$20 per tCO_2e.

With long-term goals to reach net-zero carbon emissions by 2050, carbon prices are expected to continue to rise.

For seagrass, a study[29] estimated the national coastal blue carbon stocks in the seagrass ecosystems in the countries of Southeast Asia including the Andaman and Nicobar Islands of India in the Bay of Bengal. According to this study, assuming $10/$tCO_2e$, the economic value of C_{org} of the meadows of Southeast Asia is **US$ 15,744.92 ± 4,109.19 (10^6)** (or **US$ 11.64 B to 19.85 B**), as around 1,574.20 ± 41.59 Tg of CO_2 is trapped within these seagrasses. Other highlights of this study are:

- The average value of the total carbon storage within seagrass meadows of this region is 121.95 ± 76.11 Mg ha^{-1} (average ± SD), and the total C_{org} stock of the seagrass meadows of this region was 429.11 ± 111.88 Tg, with the highest C_{org} stock in the Philippines (78%).
- The seagrass meadows of this region have the capacity to accumulate 5.85–6.80 Tg C $year^{-1}$, which accounts for **US$ 214.6–249.4 million** (assuming US$10 per tonne CO_2 equivalent).
- Under the current rate of decline of 2.82%, the seagrass meadows are emitting 1.65–2.08 Tg of CO_2 $year^{-1}$, and the economic value of these losses accounts for **US$ 21.42–24.96 million**.
- Under current loss rate, all seagrass meadows will disappear by 2060 and emit plenty of CO_2.
- The potential of the seagrass meadows to the offset current CO_2 emissions varies across the region, with the highest contribution to offset is in the seagrass meadows of the Philippines (11.71%).
- Current national policies and commitments of NDCs do not include blue carbon ecosystems as climate mitigation measures, even though seagrass ecosystems can contribute up to **7.03% of the countries' reduction goal of CO_2 emissions by 2030**.

3.3.2 Shoreline Protection

Melaleuca forest behind the coastal dunes in Terengganu, Malaysia. *(Photo by Tan Kim Hooi)*

In addition to the valuable role that coastal and marine ecosystems play in sequestering carbon dioxide (CO_2) and mitigating climate change, providing shoreline protection to coastal communities is an important, albeit not quantified, benefit, especially for adaptation and reducing vulnerabilities. By dissipating the energy of big waves, mangroves, seagrass, and coral reefs

[29] Stankovic, *et al*. 2021.

offer protection of property and life from typhoons, hurricane winds, storm surge, and tsunamis, and reduce immediate damage and future reconstruction costs. The biggest limitation to advancing the use of natural defenses in coastal management, however, is the lack of quantitative assessments of their engineering performance and economic benefits.

Studies show that mangroves maintain water quality and clarity, filtering pollutants and trapping sediments originating from land. By stabilizing sediments with their tangled root systems, mangroves help prevent erosion. Mangroves also reduce 66 percent of wave height, thereby easing erosion and flood risk.[30] The foliage of seagrass slows down water currents and traps sediments, and the seagrass roots and rhizomes are important for oxygenating and stabilizing bottom sediments and preventing erosion. Coral reefs can substantially reduce coastal flooding and erosion and act as a barrier by dissipating as much as 97 percent of incident wave energy.[31]

Coastal flooding, erosion, and storm surge from extreme weather events affect thousands of vulnerable coastal communities. The impacts of coastal flooding and associated hazards are predicted to worsen due to population growth and climate change, thus, necessitating better risk reduction and adaptation strategies. There is growing national recognition of the role of natural or nature-based solutions to climate change adaptation and coastal risk reduction. Some measurements and valuation studies have been done in certain sites, and have used the cost of seawalls and dikes as proxy measure of the shoreline protection benefit.

In the Philippines, projects of the World Bank (Wealth Accounting and Valuation of Ecosystem Services or WAVES) and UNDP (Coastal Resilience Project) estimated the value of shoreline protection provided by the coastal ecosystems in this country. According to the WAVES study (2017):

- Restoring the mangroves lost in 1950-2010 would bring more than **US$ 450 million/year** in flood protection benefits.
- Mangroves provide the most protection for frequent lower intensity storms (1-in-10-year storm events). For more catastrophic events (e.g., 1-in-25-year storm), they provide more than **US$ 1.6 billion** in averted damages throughout the Philippines.[32]

According to another study, the protection benefits generated by mangroves, seagrass, and coral reefs in the Philippines amount to **US$ 1.795 billion every year** and will benefit around 400,000 people.[33] The study also showed that the protection benefits are higher when these three ecosystems are protected as an integrated system.

[30] Spalding, MD; Brumbaugh RD; and Landis, E. 2016.
[31] United States Geological Survey (USGS) - https://www.usgs.gov/centers/pcmsc/science/role-reefs-coastal-protection?qt-science_center_objects=0#qt-science_center_objects.
[32] Wealth Accounting and the Valuation of Ecosystem Services (WAVES) 2017.
[33] UNDP/IH Cantabria. 2017.

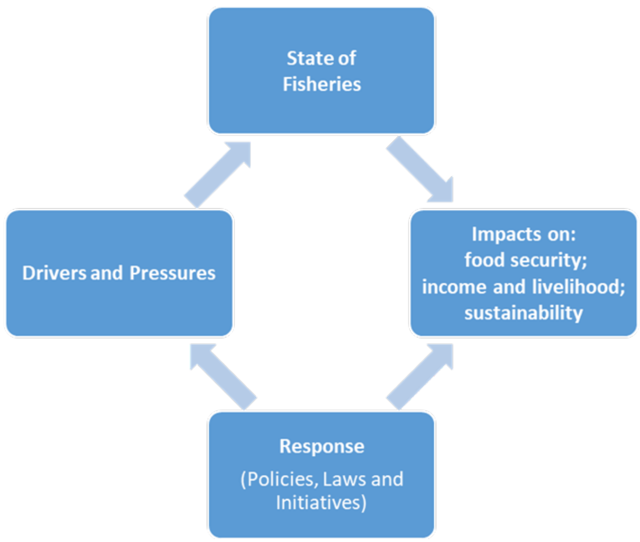
Mangroves and coral reefs. *(Photo by Thailand Environment Institute)*

PART 2

TOWARDS BLUE ECONOMY: HARNESSING OUR OCEAN WEALTH SUSTAINABLY

4 Fisheries For Food Security and Livelihood

"Give a man a fish and you feed him for a day;
teach a man to fish and you feed him for a lifetime."



SDG targets

- **Target 14.4:** By **2020**, effectively regulate harvesting and end overfishing, illegal, unreported, and unregulated fishing, and destructive fishing practices, and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics.
- **Target 14.6:** By **2020**, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing, and refrain from introducing new such subsidies…
- **Target 14.7:** By **2030**, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and tourism.
- Target 14.b: Provide access for small-scale artisanal fishers to marine resources and markets.

Aichi Biodiversity targets:

- **Target 6:** By **2020**, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches...

4.1 Fisheries Production

Fishing boats in Nha Trang, Viet Nam.
(Photo by M. Ebarvia)

Fish and seafood are among the most traded food commodities. Some 35 to 38 per cent of the world fishery production enters international trade and generated $152 billion in 2017.[34] Fish contributes a significant amount of animal protein to the diets of people worldwide. Global fish production was estimated at 172.6 million tonnes in 2017, supplying around 21 kg/capita per year and 17 per cent of global animal proteins and essential micronutrients.[35] Not only is fish a vital food, but it is also a source of work and income. Around 59.6 million people worldwide were employed in fisheries and aquaculture in 2016 and some 200 million direct and indirect employment opportunities occur along the fish and seafood value chain.[36]

At the macroeconomic level, the contribution of fisheries and aquaculture to national economies, in terms of their share to gross domestic product (GDP), exports, and employment, varies across the EAS countries. The total fisheries production in the EAS region is around 118 million tonnes, and this is 63 percent of the world production (**Table 4.1**). Aquaculture growth is highest in Cambodia, Indonesia, Malaysia and Viet Nam. On the other hand, capture fisheries has declined substantially to negative growth rates in Japan, RO Korea, and even Thailand. Commercial fisheries are a major contributor to revenue and national economic development, while coastal fisheries are a major source of national food security, rural income, and livelihoods. Aquaculture also contributes to national food security, jobs, and export earnings.

Fisheries and aquaculture employ at least 4.6 million persons in the six Coral Triangle countries; assuming an average household size of four, 18.4 million people representing five percent (5%) of the aggregate population in the Coral Triangle in 2009 were directly dependent on fisheries for livelihood.[37] In Southeast Asia, the average fish consumption is 36 kg of seafood per year, which is double the global average.[38]

In the context of blue economy, food security and sustainable livelihoods are closely related to sustainable use of biodiversity, and to the exploitation of wild fisheries. A key issue is to manage fish stocks and ecosystems, within a dynamic environment subject to climate fluctuations and change, in such a way as to maximize harvests without compromising future yields. Illegal, unreported, and unregulated (IUU) fishing is a regional and global problem that threatens ocean

[34] UNCTAD, 2019.
[35] UNCTAD, 2019.
[36] UNCTAD, 2019.
[37] ADB, 2014.
[38] Boyd, 2017.

ecosystems and sustainable fisheries. IUU fishing depletes fish stocks, destroys marine habitats, distorts competition, and weakens coastal communities. Lack of awareness, strong and effective conservation and management contribute to unsustainable fishing practices. In addition, lack of proper fish stock assessment still hampers analysis of sustainable fishing levels and efforts that would contribute to forging appropriate policies and regulations. However, there are action plans being implemented to support the sustainable fisheries in the region, such as applying the ecosystem approach to fisheries management, establishment of fish sanctuaries and MPAs, closed season for fishing (for certain species) in the Philippines and Indonesia, and reduction of total allowable catch in RO Korea.

Table 4.1: Fisheries and Aquaculture in the EAS Region.

Country	Total Fisheries[1] ('000 tonnes, 2015)	Capture Fisheries Growth (average annual %, 2000-2015)	Aquaculture Growth (average annual %, 2000-2015)
Brunei Darussalam	4.4	2.0	15.5
Cambodia	751.0	5.2	16.5
China	79,389.0	1.2	5.3
Indonesia	22,215.0	3.1	20.2
Japan	4,657.0	(2.5)	(1.0)
Korea, DPRK	774.0	0.2	1.1
Korea, RO	3,333.0	(0.7)	6.3
Malaysia	2,003.0	1.0	7.6
Philippines	4,503.0	0.8	5.2
Singapore	7.7	(9.2)	1.6
Thailand	2,590.0	(3.7)	1.3
Timor Leste	4.8	(0.8)	
Viet Nam	6,208.0	3.6	13.5
WORLD	**199,741.0**	**(0.1)**	**6.4**
EAS: TOTAL	**126,439.9**		
EAS: % of World	**63%**		

Note: [1] This refers to total capture production and aquaculture production of fish, crustaceans, mollusks, seaweeds and aquatic life, etc.
Source: World Bank, 2017.

4.1.1 Capture Fisheries

Table 4.2 shows the capture production of fish, crustaceans, molluscs, etc. by the top producers or those with capture production of 200,000 tonnes or more in 2018. Ten EAS countries are among the top capture fisheries producers. In 2018, they produced 35.8 million tonnes, and accounted for 37 percent of the total world production. There was a slight decline from the previous year's production of 35.7 million tonnes. On average, the EAS countries accounted for 39 percent of the world fisheries production from 2009 to 2018. China accounted for 14 percent of the world capture fish production in 2018, followed by Indonesia, which has a share of seven percent.

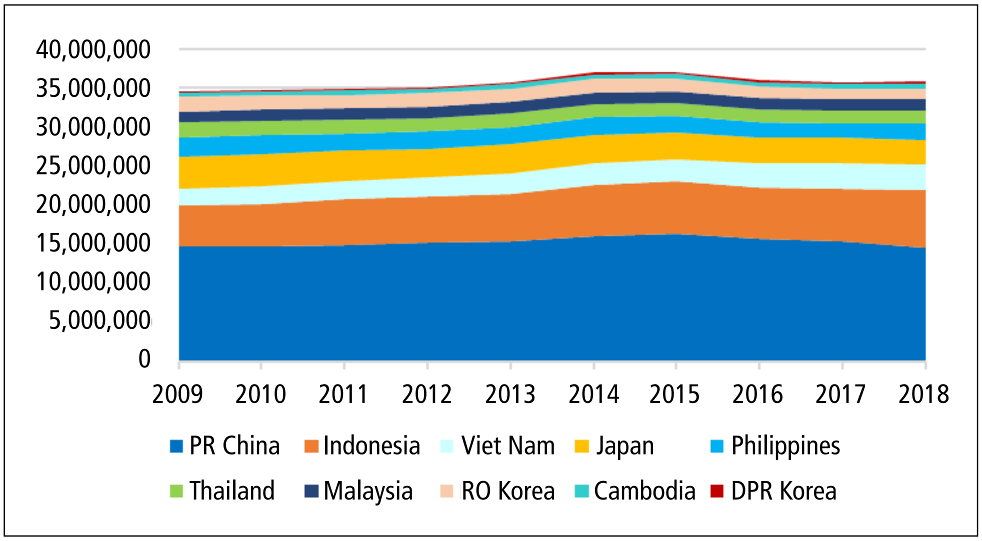
Table 4.2: Capture Production of Fish, Crustaceans, Molluscs, 2009-2018 (in tonnes).

Country	2009	2010	2011	2012	2013
China	14,786,810	14,807,437	14,989,554	15,188,657	15,350,545
Indonesia	5,111,388	5,386,309	5,753,051	5,856,860	6,125,187
Viet Nam	2,178,400	2,249,711	2,399,528	2,523,673	2,623,588
Japan	4,126,593	4,091,140	3,791,262	3,664,175	3,651,152
Philippines	2,512,059	2,500,190	2,218,153	2,203,737	2,199,259
Thailand	1,870,702	1,810,620	1,835,126	1,719,628	1,824,829
Malaysia	1,397,423	1,433,376	1,378,799	1,477,281	1,488,540
Korea, RO	1,861,061	1,721,957	1,742,332	1,667,148	1,594,785
Cambodia	465,000	490,094	560,839	566,695	639,468
Korea, DPR	207,000	217,500	219,000	213,500	209,000
TOTAL (EAS)	**34,516,436**	**34,708,334**	**34,887,644**	**35,081,354**	**35,706,353**
WORLD TOTAL	89,053,812	87,128,473	91,624,849	88,634,335	89,732,966
Share of EAS Countries	39%	40%	38%	40%	40%

Country	2014	2015	2016	2017	2018
China	16,117,803	16,386,164	15,787,554	15,373,194	14,647,819
Indonesia	6,458,735	6,689,688	6,542,228	6,736,358	7,215,215
Viet Nam	2,743,462	2,860,638	3,077,841	3,315,207	3,347,039
Japan	3,639,022	3,404,050	3,200,089	3,205,749	3,130,925
Philippines	2,246,299	2,151,467	2,024,828	1,887,058	2,049,572
Thailand	1,670,035	1,501,370	1,530,544	1,500,447	1,707,136
Malaysia	1,464,646	1,491,975	1,580,291	1,470,290	1,457,621
Korea, RO	1,744,525	1,649,805	1,360,990	1,353,619	1,336,286
Cambodia	625,255	608,193	629,950	665,993	689,155
Korea, DPR	226,000	220,000	209,000	208,700	208,700
TOTAL (EAS)	**36,935,782**	**36,963,350**	**35,943,315**	**35,716,615**	**35,789,468**
WORLD TOTAL	90,379,092	91,656,658	89,637,459	93,116,137	96,433,763
Share of EAS Countries	41%	40%	40%	38%	37%

Source: FAO, 2020.

Figure 4.1: Capture Fisheries Production (tonnes).

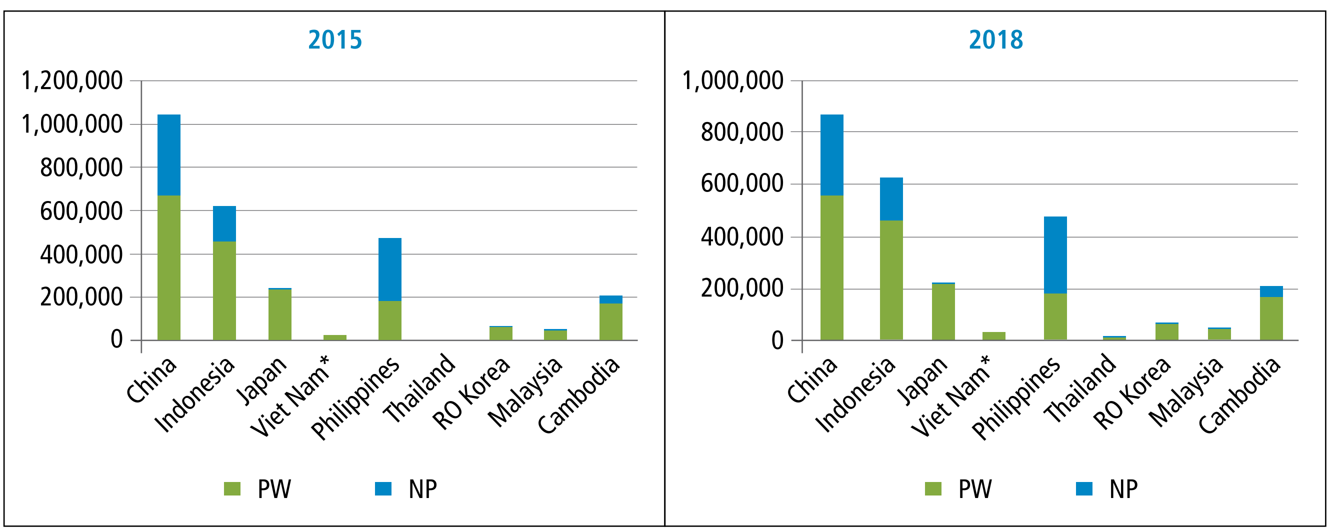


Source: FAO, 2020.

Fishing Vessels

There were 2.57 million fishing vessels in nine EAS countries[39] in 2018, of which 68 percent are motorized vessels propelled by engines, and 32 percent are unmotorized vessels propelled by oars or sails (**Figure 4.2**). These EAS countries account for about 56 percent of the world's total number of fishing vessels (4,557,709) in 2018.

Figure 4.2: Number of Fishing Vessels in 2015 and 2018.



Note: PW = powered or motorized vessels propelled by engines
NP = non-powered or unmotorized vessels propelled by oars or sails
* Reporting for Viet Nam only includes marine vessels over 90 HP.
Source: FAO 2017; FAO 2020.

[39] The nine countries – Cambodia, China, Indonesia, Japan, Malaysia, Philippines, Ro Korea, Thailand, and Viet Nam – have fish capture production of 200,000 tonnes or more. Fishing vessels in Timor-Leste (3,009) and Singapore are not included.

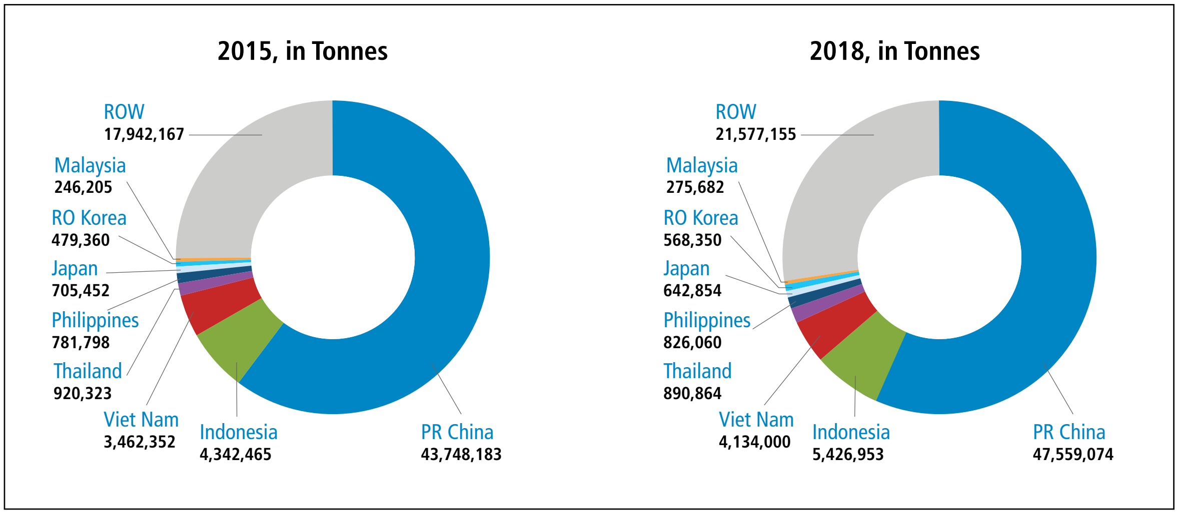
4.1.2 Aquaculture Production of Fish, Crustaceans, Molluscs, etc.

Globally, aquaculture production supplies more than 50 percent of all seafood produced for human consumption. It is one of the most resource-efficient ways to produce protein and has helped improve nutrition and food security in many parts of the world. The main driver of fish supply growth in the future will be aquaculture.[40]

China, Indonesia, Viet Nam, Thailand, Philippines, Japan, RO Korea, Cambodia, and Malaysia are among the principal aquaculture producers of fish, crustaceans, mollusks, etc. or those with production of 160,000 tonnes or more in 2018.

These nine countries from the EAS region produced 54.8 million tonnes in 2015, with a value of US$ 153.7 billion. This volume is 75.5 percent of the world aquaculture production. This increased to 60.3 million tonnes, with a value of US$ 183.8 billion in 2018, but the share of these EAS countries declined to 73.4 percent in 2018. Note that this production comes from both inland and marine waters. **Figure 4.3** shows the aquaculture production in 2015 and 2018.

Figure 4.3: Aquaculture Production of Fish, Crustaceans, Molluscs, Etc. in 2015 and 2018.



Note: These countries are those with production of 160,000 tonnes or more in 2018.
ROW: rest of the world
Source: FAO 2017; FAO 2020.

China accounted for 60 percent of the total aquaculture production in the world in 2015, and 58 percent in 2018. It has achieved a fundamental change from reliance on "fishing" to "farming". The production of China's fish farming increased steadily from 38,288,300 tonnes in 2010 to 49,379,000 tonnes in 2015, an increase of 29 percent, with an average annual growth rate of

40 UNCTAD, 2016.

5.8 percent. In 2015, freshwater aquaculture in China accounted for about 60 percent of its total production, while 40 percent for the marine water aquaculture.

Indonesia is the third top aquaculture producer, accounting for six percent of the world aquaculture production in 2015, and increased to seven percent in 2018. Around 61 percent of the aquaculture production (including seaweeds) in Indonesia is from marine waters; while culture in brackishwater accounted for 17 percent, and freshwater culture accounted for 22 percent.

Igang Marine Station of SEAFDEC in Guimaras. *(Photo by M. Ebarvia)*

4.1.3 Production of Aquatic Plants

a. Capture Production

China, Indonesia, Japan, RO Korea and the Philippines are among the top producers of seaweeds and other aquatic plants, accounting for 35 percent of the world's capture production (**Figure 4.4**).

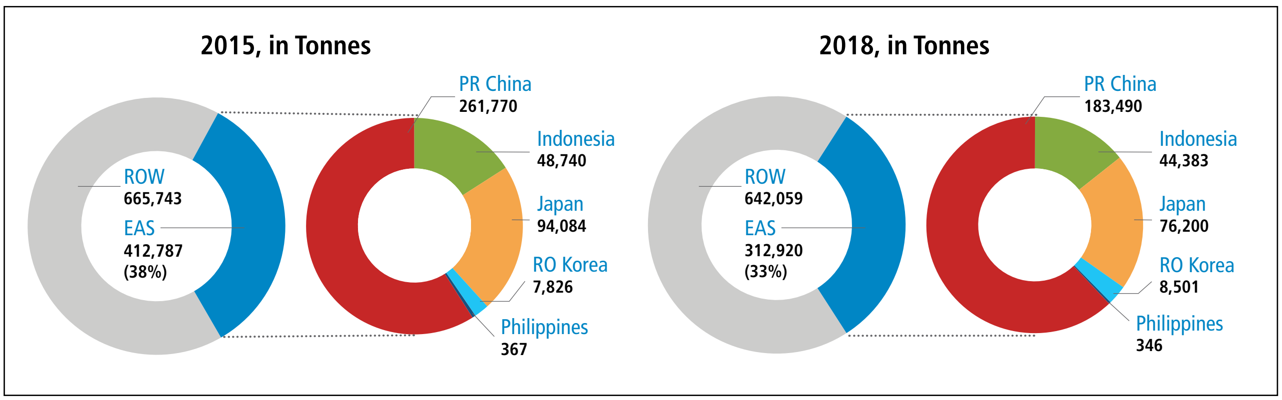
Table 4.3 shows the annual production of seaweeds and other aquatic plants (expressed in tonnes, on a wet-weight basis) through harvesting of wild stocks. Capture production of aquatic plants has declined in China, Japan, RO Korea, and the Philippines between 2009 and 2018, but it increased tremendously in Indonesia for the same period.

Table 4.3: Capture Production of Seaweeds and Aquatic Life, 2009-2018 (In Tonnes).

Country	2009	2012	2015	2016	2017	2018
China	276,170	257,640	261,770	231,707	203,490	183,490
Indonesia	3,030	7,641	48,740	41,194	46,919	44,383
Japan	104,103	98,514	94,084	80,721	69,969	76,200
RO Korea	10,843	10,123	7,826	9,505	8,172	8,501
Philippines	434	405	367	364	352	346
Total (EAS)	**394,580**	**374,323**	**412,787**	**363,491**	**328,902**	**312,920**
WORLD Total	1,112,911	1,144,625	1,078,530	1,110,416	1,128,689	954,979
Share of EAS	35%	33%	38%	33%	29%	33%

Source: FAO, 2020.

Figure 4.4: Capture Production of Seaweeds and Other Aquatic Plants, 2015 and 2018.



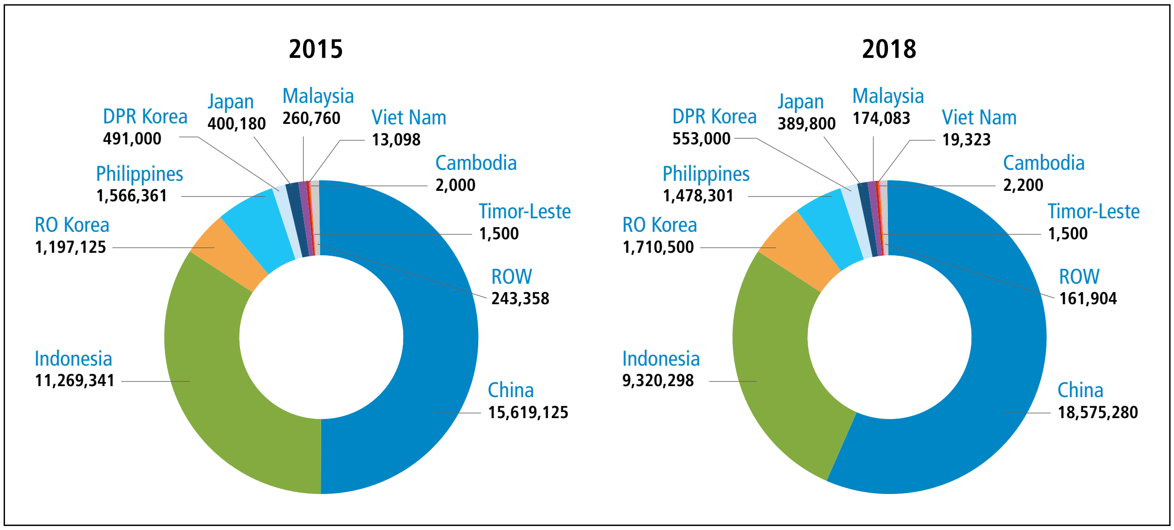
Source: FAO, 2020.

b. Aquaculture Production of Seaweed and Other Aquatic Plants

Total aquaculture production of aquatic plants in 2018 was 32,386,189 tonnes. China and Indonesia are the top producers of seaweeds and other aquatic plants through aquaculture. Between 2015 and 2018, aquaculture production of seaweeds increased in China, RO Korea, DPR Korea, and Cambodia while it declined in other EAS countries (**Table 4.4**). While the EAS region contributes a third of the world's capture production of seaweeds, the share of the EAS countries in the world's aquaculture production of seaweeds is 99.5 percent (**Figure 4.5**), with a value of US$ 13.2 billion (**Table 4.4**).

Seaweed farmer in Bali, Indonesia.
(Photo by JM Hullot is licensed under CC BY-SA)

Figure 4.5: Aquaculture Production of Seaweeds and Other Aquatic Plants, 2015 and 2018.



Source: FAO, 2020.

Table 4.4: Aquaculture Production of Seaweeds and Aquatic Life in 2015 and 2018.

COUNTRY	2015		2018	
	Quantity (tonnes)	Value (US$ 1000)	Quantity (tonnes)	Value (US$ 1000)
China	15,619,125	7,983,412	18,575,280	9,493,501
Indonesia	11,269,341	841,661	9,320,298	1,382,968
Korea, RO	1,197,125	440,837	1,710,500	813,312
Philippines	1,566,361	182,678	1,478,301	207,291
Korea, DPRK	491,000	73,750	553,000	83,100
Japan	400,180	868,181	389,800	1,212,646
Malaysia	260,760	33,384	174,083	12,943
Viet Nam	13,098	3,534	19,323	5,289
Cambodia	2,000	400	2,200	440
Timor-Leste	1,500	150	1,500	150
ROW	243,358	44,201	161,904	69,662
WORLD TOTAL	**31,063,848**	**10,472,188**	**32,386,189**	**13,281,302**

Note: The data in this table refer to the aquaculture production of seaweeds and other aquatic plants expressed in tonnes and on wet-weight basis.
Source: FAO, 2020.

4.2 Tuna Fisheries

The global demand for tunas has been dramatically growing in recent years reflecting a shift of consumers' preference to fish as protein source. The world tuna markets have substantially expanded and diversified into tuna sashimi and canned tuna. The status of tuna stocks of the world depend on the regions/areas as well as on the species. Although some species are reported to be over-exploited, production of other species is continuously stable due to the conservation and management efforts by Tuna Regional Fisheries Management Organizations (RFMOs).[41]

Tuna sold at the Gen. Santos Fish Port, Philippines. (Photo by M. Ebarvia)

Tunas are economically important in the Southeast Asian region, generating export revenues for the countries and providing important protein sources for domestic consumption. As reported, the total tuna production from Southeast Asian waters increased from 0.87 million tonnes in 2001 to 1.94 million tonnes in 2008, including five oceanic tuna species, namely: bigeye, yellowfin, skipjack, albacore, and bluefin tuna, as well as from four neritic species, such as bullet tuna, frigate tuna, eastern little tuna, and longtail tuna.

Table 4.5 shows the stock status of interest to the Western and Central Pacific Fisheries Commission (WCPFC) as of 2019. The Western and Central Pacific Ocean (WCPO) region contains stocks of four oceanic tuna species that are commercially harvested:

- Albacore (*Thunnus alalunga*)
- Bigeye (*Thunnus obesus*)
- Skipjack (*Katsuwonus pelamis*)
- Yellowfin (*Thunnus albacares*)

Table 4.5: Overview of Stock Status of Interest to the WCPFC (2019).

Stock	Latest Assessment	Overfished*	Overfishing*	Next Assessment
WCPO Tuna				
01 Bigeye tuna (*Thunnus obesus*)	UPDATE 2018 (SC14)	No (100%)	No (94%)	2020
02 Yellowfin tuna (*Thunnus albacares*)	2017 (SC13)	No (92%)	No (96%)	2020
03 Skipjack tuna (*Katsuwonus pelamis*)	2019 (SC15)	No	No	2022
04 South Pacific albacore tuna (*Thunnus alalunga*)	2018 (SC14)	No	No	2021

41 Siriraksophon, S. 2017.

Table 4.5: Overview of Stock Status of Interest to the WCPFC (2019). (cont.)

Stock	Latest Assessment	Overfished*	Overfishing*	Next Assessment
Northern Stocks				
05 North Pacific albacore (*Thunnus alalunga*)	2017 (SC13)	No	No	2020
06 Pacific bluefin tuna (*Thunnus orientalis*)	UPDATE 2018 (SC14)	Yes	Yes	2020
07 North Pacific Swordfish (*Xiphias gladius*)	2018 (SC14)	No	No	2022
WCPO Billfish				
08 Southwest Pacific swordfish (*Xiphias gladius*)	2017 (SC13)	No (100%)	No (68%)	2021
09 Southwest Pacific striped marlin (*Kajikia audax*)	2019 (SC15)	Likely (50%)	No (56%)	2023
10 North Pacific striped marlin (*Kajikia audax*)	2019 (SC15)	Yes	Yes	2024
11 Pacific blue marlin (*Makaira nigricans*)	2016 (SC12)	No	No	TBD
WCPO Billfish				
12 Oceanic Whitetip Shark (*Carcharhinus longimanus*)	2019 (SC15)	Yes	Yes	TBD
13 Silky shark (*Carcharhinus falciformis*)	2018 (SC14)	No (indicative)	Yes (indicative)	2023
14 South Pacific blue shark (*Prionace glauca*)	2016 (SC12)	N/A	N/A	2021
15 North Pacific blue shark (*Prionace glauca*)	2017 (SC13)	No	No	2022
16 North Pacific shortfin mako (*Isurus oxyrinchus*)	2018 (SC14)	No (>50%)	No (50%)	2023
17 Pacific bigeye thresher shark (*Alopias superciliosus*)	2017 (SC13)	N/A	N/A	2022
18 Southern Hemisphere Porbeagle shark (*Lamna nasus*)	2017 (SC13)	N/A	Very low	2022
19 Whale Shark (*Rhincodon typus*)	'PS Risk' 2018 (SC14)	N/A	N/A	TBD

* The determination of overfished and overfishing is a likelihood, not a firm statement – where a percentage is provided to indicate probability.
Source: WCPFC.

4.2.1 Status and Condition of Tuna Fisheries in the West Pacific East Asia (WPEA)

The information in this section is from the Sustainable Tuna Fisheries for Blue Economy[42]– a report of the West Pacific East Asia (WPEA) Project, which is a GEF-financed and UNDP-supported initiative, and it is being implemented by the Western and Central Pacific Fisheries Commission (WCPFC) along with national implementing partners from the three beneficiary countries of Indonesia, the Philippines and Viet Nam. The WPEA project has facilitated more inclusive involvement of EAS countries in regional management of migratory tuna stocks – one of the foundations of a sustainable blue economy.

[42] PEMSEA, 2018.

a. Tuna production (volume and value)

Indonesia

The cumulative tuna catches from Indonesian fishery management areas that fall within the WCPFC Statistical Area (FMA 713, 714, 715, 716 and 717) was 525,238 tonnes in 2016 (**Table 4.6**), which is about 10.7 percent of the global tuna catch.

The top tuna-fishing nation the world is Indonesia. Considering 2012 global production, Indonesia accounted for 12 percent, i.e., 566,153 tonnes of the 4,610,007 tonnes worldwide (Macfayden et al. 2016). Most of Indonesia's catch, 77 percent, is in the WCPO, but much of the longline catch originates in the Eastern Indian Ocean. Catches were landed by several gear types, and there is a strong reliance on "other" gears, making up 32 percent of the total Indonesian catch in 2012.

Indonesia has a substantive domestic market, serving a population of more than 250 million. Exports have significantly grown over the past 10 years, but there has been a decline in frozen whole and skipjack fillets in 2015 and 2016, primarily due to a decrease in exports to Thailand, which is the largest producer of canned tuna in the world – but is reliant upon imports of raw materials.

Table 4.6: Indonesia Tuna Catch in WCPFC Statistical Area, 2000-2016.

Year	Skipjack (tonnes)	%	Yellowfin (tonnes)	%	Bigeye (tonnes)	%	TOTAL TUNA (tonnes)
2000	220,717	64%	105,317	31%	16,167	5%	342,200
2001	203,101	64%	96,911	31%	14,876	5%	314,888
2002	195,213	64%	93,147	31%	14,299	5%	302,659
2003	199,129	64%	95,016	31%	14,585	5%	308,730
2004	262,179	64%	125,100	31%	19,204	5%	406,483
2005	173,203	70%	63,625	26%	10,688	4%	247,515
2006	217,310	76%	55,920	20%	12,612	4%	285,842
2007	243,118	76%	67,773	21%	10,999	3%	321,890
2008	255,918	76%	63,055	19%	15,613	5%	334,586
2009	279,985	72%	92,887	24%	15,762	4%	388,635
2010	273,637	76%	73,846	21%	10,771	3%	358,253
2011	270,101	68%	114,442	29%	12,901	3%	397,444
2012	272,052	61%	151,789	34%	19,476	4%	443,317
2013	351,901	67%	146,646	28%	20,446	4%	518,993
2014	322,840	67%	136,210	28%	23,868	5%	482,918
2015	262,927	61%	146,196	34%	22,953	5%	432,076
2016	336,455	64%	160,092	31%	28,344	5%	525,238

Source: WCPFC 2017b. Annual report to 13th SC session, August 2017.

Philippines

For the Philippines, the reconciled cumulative total tuna catches from Philippine waters in 2016 were 143,557 tonnes (**Table 4.7**). An additional 71,394 tonnes were recorded from Philippine flagged purse seine vessels operating in Papua New Guinea waters.

Tuna catches in the Philippines in 2012 were just under 250,000 tonnes, comprising approximately five percent of the global catch. The Philippine catch is made up by multiple gear types, but predominantly purse seines.

Tuna is one of the largest seafood export commodities of the Philippines in terms of value. Over the same period the Philippines obtained *GSP+ status* from the European Union. The Philippines is best known for its high quality, fresh yellowfin tuna (*Thunnus albacares*) and is currently the largest supplier of fresh yellowfin tuna to the European Union.[43]

Table 4.7: Philippines Reconciliation of 2016 Tuna Catch Estimates by Gear and Species (in Tonnes).

Gear	Skipjack	Yellowfin	Bigeye	TOTAL
Purse seine	41,415	15,967	908	**58,290**
Ringnet	26,475	8,290	636	**35,401**
Hook-and-line	7,818	31,781	1,177	**40,776**
Others	6,420	2,546	124	**9,090**
Total	**82,127**	**58,584**	**2,845**	**143,557**

Note: Provisional catch estimate does not include catches of Philippine flagged purse seine vessels in PNG which accounts for around 71,394 MT for 2016.
Source: WCPFC 2017c. Annual report to 13th SC session, August 2017.

Viet Nam

The cumulative tuna catch in 2016 in Viet Nam's EEZ for the three species of bigeye, yellowfin and skipjack was 123,076 tonnes (**Table 4.8**). The annual catch in Viet Nam in 2012 was 65,556 tonnes, about 1.5 percent of the global total, and included gillnet, longline and purse seine catches.

The tuna exports in 2016 reached US$ 500 million, with shipments to the United States worth US$ 200 million, a year-on-year increase of 4.5 percent, and US$ 110 million to the European Union, an increase of 11.5 percent over 2015 figures.[44] Frozen tuna loins were the primary product in

[43] SeafoodSource, 2017.
[44] Seafood Trade Intelligence Portal, 2018.

terms of value, followed by canned tuna and frozen whole tuna. In 2014, Viet Nam became the third major seafood exporter, overtaking Thailand as the leading Southeast Asian exporter. The Viet Nam Association of Seafood Exporters and Producers (VASEP) reports an export value in 2016 of US$ 7.05 billion, indicating that the tuna exports comprise approximately seven percent of the total.[45]

Table 4.8: Viet Nam Tuna Catch Caught in Viet Nam's EEZ for Three Fisheries in 2016 (in Tonnes).

Gear	Bigeye	Yellowfin	Skipjack	TOTAL
Gillnet	1,671	771	44,997	**47,439**
Purse seine	2,918	6,617	48,564	**58,099**
Longline/ Handline	1,115	16,423	N/A	**17,538**
Total	**5,704**	**23,811**	**93,561**	**123,076**
Proportion (%)	**4.63%**	**19.35%**	**76.02%**	**100%**

Source: WCPFC 2017d. Annual report to 13th SC session, August 2017.

b. Transshipment ports

Fishing ports in Indonesia are an important component to the fisheries system and supply chain. The Directorate General of Capture Fisheries (DGCF) classifies four types of fishing ports: Oceanic Fishing Ports (OFPs), Archipelagic Fishing Ports (AFPs), Coastal Fishing Ports (CFPs) and Fish Landing Centers (FLCs). FLCs are managed by provincial governments; the other three categories by the Ministry of Marine Affairs and Fisheries. Benoa (state-enterprise owned) is considered as the main tuna landing port, but Muara Baru, Bitung, Ambon and Sorong are also important.

The Philippines has eight main fish port complexes: (1) General Santos Fish Port Complex, (2) Navotas Fish Port Complex, (3) Iloilo Fish Port Complex, (4) Lucena Fish Port Complex, (5) Zamboanga Fish Port Complex, (6) Davao Fish Port Complex, (7) Sual Fish Port Complex, and (8) Camaligan Fish Port. The General Santos and the Navotas Fish Port Complex account for 83 percent of the landings landed at these fish ports.[46] There are also city and municipal fish ports, and community fish landing centers managed under the local governments.

In Viet Nam, tuna catches are landed at over 60 landing sites along the coast of 28 coastal provinces. For oceanic tuna, they are unloaded mainly at ten fishing ports in Binh Dinh, Phu Yen and Khanh Hoa provinces (VN-NTMP, 2012).

[45] Seafood Trade Intelligence Portal, 2018.
[46] Seafood Trade Intelligence Portal, 2018.

c. Tuna canning industry

The three EAS countries of Indonesia, Philippines and Viet Nam have significant tuna canning industries.

In 2014, canned tuna exports from Indonesia were 70,814 tons (Seafood Trade Intelligence Portal, 2018), making the country the sixth largest exporter of canned tuna products. Indonesian canneries have seen a drop in raw materials in recent years because of the measures the government is taking on IUU fishing.

The Philippines also has a substantive tuna canning industry. The IUU fishing measures implemented by the government of Indonesia have also impacted raw material supply to Philippine canneries, but the GSP+ status recently obtained has bolstered exports to the EU. Apart from GSP+ status, companies are facing increasing pressure to fulfil quality criteria, and ensuring sustainably and equitably sourced tuna. For instance, Greenpeace has published reports ranking the performance of tuna canneries in Southeast Asia, including the Philippines and Indonesia.

The tuna canning industry in Viet Nam, along with overall tuna exports, is growing. In 2016, the value of Vietnamese tuna exports was US$ 500 million, a 9 percent increase from the previous year. Frozen tuna loins and canned tuna accounted for 47 percent and 30 percent, respectively (SeafoodSource 2017).

d. Emerging and escalating issues

Emerging and escalating issues include, but are not limited to the following:

- Climate change: potential distribution shifts, including skipjack and bigeye distribution shifting towards the central and eastern Pacific.
- Supply: approaching global limits.
- Demand: modest increase expected, considering flat supply and population growth.
- Global price: slow increase in canned and fresh tuna.
- Harvesting costs: fuel costs expected to remain on increasing trend.
- Harvesting technology: improvements in purse seining, reducing bycatch on drifting FADs.
- Fisheries monitoring and surveillance: further advances in technology expected, further reducing enforcement costs; however, capital investment demands are high.
- Demographic changes: demand on tuna fisheries expected to increase as coastal fisheries decline because of over-fishing and climate change.
- External governance: trade preferences of foreign partners could shift to other producers.
- WCPFC might take measures to conserve bigeye stocks, if over-fishing determined.
- Increasing catch of tuna in the Open Ocean or high seas, taken beyond the exclusive economic zones (EEZs) of maritime countries or Areas Beyond National Jurisdiction (ABNJ)

e. Tuna management plans

The three EAS beneficiary countries of the WPEA project, Indonesia, Philippines, and Viet Nam, have developed and approved **National Tuna Management Plans** (NTMPs). This is the first time that management plans for tuna fisheries have been formulated in these countries – another positive step towards achieving sustainable management of migratory tuna stocks. The ecosystem-based approach to fisheries management (EAFM) is among the key principles of the NTMP's for the three beneficiary countries.

4.2.2 Neritic Tuna

Oceanic and neritic tunas are abundant and commonly found in the waters throughout Southeast Asia. While oceanic tunas migrate over oceans and seas, neritic tunas mostly inhabit the economic zones and subregional marine waters of EAS. While the catch of the oceanic tunas is reported to have declined, the catch of the neritic tuna species continues to increase. This make neritic tuna species becoming more important and increasingly the target of exploitation by commercial and local fisheries, especially now that attractive prices are offered by processing companies for such species.

Therefore, it is necessary to address the status of and uncertainties in the distribution, migration, and utilization of neritic tuna stocks in the waters and sub-regions of the EAS, prior to the development of appropriate tuna management measures and plans at the national and sub-regional levels. ASEAN member countries adopted the **Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region in 2015**. The key objectives are actions are presented in **Table 4.12**.

4.2.3 Catch of Tuna in the Open Ocean[47]

The world catch of tuna in the Open Ocean, taken beyond the exclusive economic zones (EEZs) of maritime countries, has increased from about 125,000 tonnes per year in the early 1950s to a plateau of about 3.5 million tonnes per year from 2000 to 2010 (**Table 4.9**, **Figure 4.7**). This overall catch, consisting of declining landings from the Atlantic and Indian Oceans and increasing landing from the Pacific Ocean is not likely to increase in the future, nor even to be maintained. Most of this catch, consisting of skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*) and albacore tuna (*T. alalunga*) is traditionally taken by Japan, South Korea and Taiwan (China), but new entrants are attempting to increase their share, notably in the Pacific. Given the current states of tuna stocks in the Open Ocean and the effects of ocean warming on tuna stocks, this should result in increased competition among the subsidized fleets of

[47] The information in this section is from: Pauly, Daniel and Vicky W.Y. Lam. 2011. Accessed from: http://onesharedocean.org/open_ocean/fisheries/tuna_catch

developed countries with distant-fishing fleets, and between established fleets and new entrants. Of these new entrants, three are developing countries (Indonesia, the Philippines and Mexico) which appear among the 10 countries with the largest tuna catch in the Open Ocean.

Oceanic tunas are exploited using pole and line, longline, driftnet and purse seining. The catch of tuna that were taken outside EEZs in the open ocean since 2000 is about 65 percent of the total catch of tuna in the world. The 10 countries with the highest tuna catch in the open ocean contribute to about 70 percent of all the oceanic tuna catch.

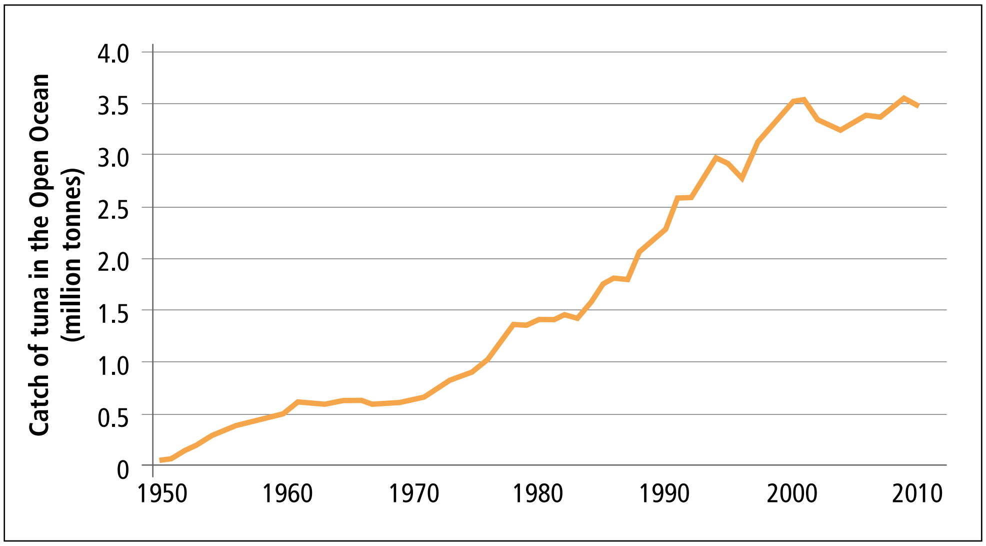
The Western and Central Pacific region (FAO 71) has the highest volume of tuna landings among all FAO statistical regions, averaging 1.4 million tonnes per year. Eighty-seven percent of the total tuna catch in the open oceans comprises major species: e.g., skipjack, yellowfin and bigeye. Time series trends of tuna catch in the open ocean show that the catch of tuna increased between 1950 and 2001, then plateaued in the last decade or so. The reason for this – besides the fact that a few species (Atlantic, Pacific and Southern bluefin tuna) have been severely overfished and will not again reach the high catches of the past – is that the few species that presently contribute the bulk of tuna catches (yellowfin, albacore, skipjack and bigeye tuna) are currently experiencing fishing mortality roughly generating maximum sustainable yield, and additional increases are likely to decrease catches.

Table 4.9: Decadal Catch of Tuna (103 Tonnes) in the Open Ocean of the Top 10 Economies with the Highest Landings from 2000 to 2010.

Country	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2010
Japan	**1,640**	**3,929**	**3,469**	**5,451**	**8,246**	**4,617**
Taiwan, China	**53**	**246**	**563**	**1,148**	**2,764**	**2,351**
South Korea	**1**	**110**	**1,199**	**1,954**	**3,197**	**2,339**
Indonesia	**0**	**124**	**338**	**977**	**2,269**	**1,945**
Spain	9	39	258	717	1,377	1,188
Ecuador	0	0	101	314	727	1,121
Philippines	**86**	**106**	**716**	**955**	**1,032**	**1,027**
Mexico	8	44	138	742	1,226	917
France	19	171	490	818	1,106	721
USA	971	1,155	1,504	1,500	1,334	689

Source: Pauly, Daniel and Vicky W.Y. Lam. 2011.

Figure 4.6: Annual Catch of Tuna Species in the Open Ocean, 1950-2010 (Million Tonnes)



Source: Pauly, Daniel and Vicky W.Y. Lam. 2011.

Key findings

- Tuna fisheries globally land about 3.5 million tonnes of fish annually. Their level of exploitation is economically and socially relevant.
- The biomass of tuna is now at the threshold of overfishing. Further increases are not likely as they are fully exploited.
- If the total overall catch remains the same as present level, there will be increasing competition with new fleets are appearing, although catches may decline in response to global warming

4.3 Fishers

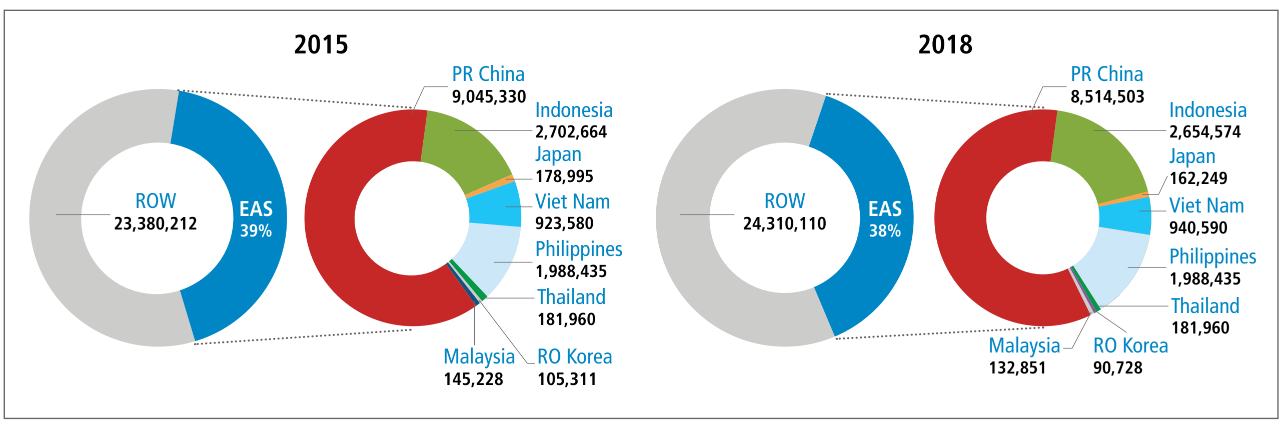
There were 14.7 million people in the EAS region who rely on capture fisheries for their livelihood in 2018. This is around 38 percent of the total number of fishers in the world. **Table 4.10** shows the number of fishers in the EAS countries that are among the top fish capture producers in 2005-2018. For eight countries, the number of fishers went down from 15.2 million in 2015 to 14.7 million in 2018. Of these, 8.5 million are from China, and this is 58 percent of the number of capture fishers in the EAS region, and 22 percent of the total number of fishers in the world (**Figure 4.7**). Note that aquaculture, fish and seafood processing and marketing also create jobs and business opportunities in coastal communities.

Table 4.10: Number of Fisherfolk.

Country	2005	2010	2013	2014	2015	2016	2017	2018
China	8,759,162	9,013,173	9,238,837	9,165,990	9,045,338	8,795,228	8,692,055	8,514,503
Indonesia	2,463,237	2,620,277	2,640,095	2,667,440	2,702,664	2,601,638	2,662,083	2,654,574
Japan	222,160	217,870	192,510	184,553	178,995	170,530	162,976	162,249
Viet Nam	1,075,122	1,033,885	940,855	942,130	923,580	940,590	940,590	940,590
Philippines	1,901,000	1,988,435	1,988,435	1,988,435	1,988,435	1,988,435	1,988,435	1,988,435
Thailand	187,300	155,000	160,000	160,000	181,960	181,960	181,960	181,960
RO Korea	171,170	138,288	119,110	115,773	105,311	100,296	98,228	90,728
Malaysia	99,903	138,749	155,011	154,344	145,228	137,604	135,764	132,851
Cambodia	729,893	673,963	578,468	578,468				
DPR Korea	119,277	119,277						
Timor-Leste					4,723*			
Total	**15,728,224**	**16,098,917**	**16,013,321**	**15,957,133**	**15,276,234**	**14,916,281**	**14,862,091**	**14,665,890**
WORLD	36,655,000	39,305,000	37,962,000	37,879,000	38,771,000	38,856,000	38,910,000	38,976,000
Share of EAS Countries	43%	41%	42%	42%	39%	38%	38%	38%

*Source: FAO, 2020; *PEMSEA and MAF, Timor-Leste 2019.*

Figure 4.7: Number of Fishers in 2015 and 2018.



Note: ROW – rest of the world
Source: FAO, 2020.

Small-scale fisheries

According to FAO (2015), small-scale fisheries contributed about half of global fish catches. Fishing and related activities often underpin the local economies in coastal, lakeshore, and riparian communities and constitute an economic and social engine, generating multiplier effects in other sectors while underpinning the livelihoods of these communities.[48] Small-scale inshore fisheries are the backbone of socio-economic well-being in coastal communities, where fish is crucial for food security and health, providing not only daily protein requirements, but also a range of essential micronutrients that fend off diseases of malnutrition.[49] Moreover, fisheries forms part of their traditional cultural identity.

Small-scale fisheries are those that exhibit some or all of the following characteristics: (i) primarily geared toward household consumption, sale at the local level, or export in the case of high value species; (ii) usually at low level (primary and secondary) of economic activity; (iii) for fulfilling cultural or ceremonial purposes; (iv) non-mechanized, or involve low capacity (lower gross tonnage and horsepower), low technology, and low capital investment; (v) undertaken by the fisher and/or family members only; (vi) conducted within inshore areas; and (vii) minimally managed.[50]

Commercial or industrial fisheries are the large-scale, commercial fishing operations that involve substantial capital investment and take place in coastal or offshore fishing grounds, in which fishing is typically carried out by a crew and lasts from days to months at a time.

The definition and terminology for small-scale fishers varies from country to country (**Table 4.11**).

In Cambodia, 'coastal fisheries' is used to refer to small-scale fisheries, and involves family-scale fishing units operating from the coast to a depth of 20 m.[51]

In Malaysia, small-scale fisheries are the traditional fisheries using traditional gears, such as hook-and-line, bagnets, traps, lift nets, seine nets, barrier nets, and scoop nets.

In Thailand, the classification is based on boat gross tonnage, whereby small-scale is defined as inboard powered boats of less than 10 gross register tonnage (GRT), and that generally operate inshore.

In Viet Nam, fisheries are commonly classified as near-shore and offshore rather than as small and large scale.[52]

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[48] FAO, 2015.
[49] Teh and Pauly, 2018.
[50] Teh and Sumaila, 2013; Teh and Pauly, 2018.
[51] FAO, 2011; FAO, 2017.
[52] Pomeroy *et al*., 2009.

In the Philippines, the classification is municipal fisheries and commercial fisheries. Municipal marine capture fisheries operate in coastal waters within 15 km from the coastline ("municipal marine waters"), using vessels of up to 3 gross tonnage (GT) or without the use of vessels. Commercial fisheries operate outside municipal waters, using vessels 3 GT or larger. Small-scale commercial fishing is undertaken by fishers utilizing vessels between 3.1 GT and 20 GT.

Table 4.11: Categories of Fisheries in the Gulf of Thailand.

	Industrial	Small-scale	Sectors covered in national statistics
Cambodia	Boats >30m	Family-scale fishing units, fishing up to depth of 20m	Boats >30m that pay tax
Malaysia	Deep-sea fishing vessels > 70 GRT that operate beyond 30 nautical miles from shore, and fishing with commercial gears (trawl, purse seine, driftnet, and gill net)	Fishing with traditional gears (hook-and-line, bag net, trammel net, lift net, and traps)	Licensed industrial and traditional gears
Thailand	Inboard powered boats >5 GRT	Boats <5 GRT that operate near shore, with inboard or outboard engines, or are non-powered	Landed industrial and small-scale catches
Viet Nam	"Offshore" boats with engines >90 hp	Near-shore fisheries	Not Specified

Note: GRT - gross register tonnage
Source: Teh and Pauly, 2018.

FAO (2015) pointed out that:

- Small-scale and artisanal fisheries: (a) encompass all activities along the value chain – pre-harvest, harvest and post-harvest – undertaken by both men and women; and (b) employ more than 90 percent of the world's capture fishers and fish workers, about half of whom are women.
- In addition to employment as full- or part-time fishers and fish workers, seasonal or occasional fishing and related activities provide vital supplements to the livelihoods of millions. These activities may be a recurrent sideline activity or become especially important in times of difficulty.
- Many small-scale fishers and fish workers are self-employed and engaged in directly providing food for their household and communities as well as working in commercial fishing, processing and marketing.

There has been a tendency for governments to focus more on large-scale, commercial fisheries for national socioeconomic growth. As marginalized sectors, small-scale fisherfolk are more vulnerable to the negative impacts of habitat loss, pollution, and climate change as well as competition with commercial fisheries and other ocean economic sectors. There are cases where commercial fisheries have crowded out small fishers from their traditional fishing grounds, and where large-scale trawling have damaged habitats. Limited access to fish landing ports, processing and cold storage facilities, and markets have resulted in post-harvest losses and income losses for the small fishers, who are among the poorest in society.

Activities, such as gleaning by women and children have until recently not been recognized for their important role in securing household food and nutritional requirements.[53] For example, in Timor-Leste, women were actively fishing more days per month than men, and gleaning was the most frequent activity, with 100 percent of trips returned with catch for food and/or income.[54] For empowered women, the COVID-19 pandemic is not an obstacle. During the lockdown when fishing was restricted, the Pantad Women Fisherfolk Association in Dumalinao, Zamboanga del Sur, Philippines ventured into the production of seaweed crackers and other local seaweed-based delicacies. Using their savings, they started their business on buying and selling raw dried seaweeds and retailing of agri-fishery and veterinary supplies (http://prdp.da.gov.ph/seaweeds-sustains-womens-group-through-the-pandemic/). The current lack of data on women's contributions and engagement highlights a critical gap in fisheries management.

The crucial role that small-scale fisheries and women contributes to food security and nutrition, livelihoods, poverty reduction, sustainable resource use, equitable development, and traditional knowledge should be accounted for and highlighted in regional and national fisheries management. The lack of information and the undervaluation of small-scale fisheries can result in macroeconomic and sectoral development plans that overlooks their contribution, and this could undermine efforts on ensuring food security, resiliency, and local/national economic stability. Note that SDG Target 14.b is aimed at providing access of small-scale artisanal fishers to marine resources and markets, while SDG 5 focuses on gender equality and empowerment of women.

Haenyo – Jeju Island women-divers (Photo by Jeju Tourism Org)

[53] Harper *et al*., 2013.
[54] Tilley *et al*., 2020.

4.4 Pressures

Fisheries during recent decades has been undertaken in an unsustainable manner in several parts of the world leading to degradation of fish stocks, loss of habitats, ecosystems and biodiversity. The resulting economic loss is estimated at US$83 billion per year for fisheries and over US$6 billion per year from diseases in aquaculture.[55] This is further exacerbated by climate change, which is likely to have a severe effect on fishing and fish farming communities in many parts of the world.

Major threats to the fisheries stocks include the ever-increasing fishing pressure brought about by the growing number of fishers per fishing area and the use of more efficient fishing gears and mechanized fishing operations. IUU fishing has resulted in dwindling fish abundance in many areas in the region. The use of destructive fishing methods (e.g., cyanide, blast fishing, and fine mesh nets) has long contributed to the rapid decline of fish stocks and habitat degradation. By-catch and discards from trawling are also considered as threats to fisheries sustainability. Decreasing numbers of fish are also the direct results of loss of mangroves and seagrass beds, diminishing coral cover, land use changes, and pollution in coastal and marine areas.

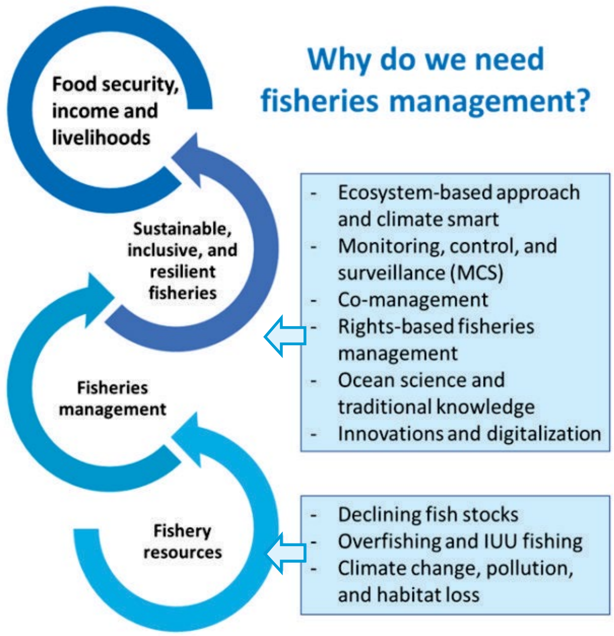
Here are the disturbing statistics: 33.1 percent of world fish stocks are subject to overfishing.[56] Around 58 percent of monitored global fish stocks are fully exploited, and 31 percent of stocks are overexploited.[57] The proportion of fish stocks that are within biologically sustainable levels decreased from 90 percent in 1974 to 65.8 percent in 2017, while the percentage of stocks fished at biologically unsustainable levels increased from 10 percent in 1974 to 34.2 percent in 2017.[58]

IUU fishing worldwide is estimated at somewhere "between 13 and 31 percent of reported catches, and over 50 percent in some regions," and valued at up to US$23 billion per year.[59]

Small-scale fisheries in Southeast Asia tend to be overshadowed by the large-scale commercial (industrial) fishing sector. The biased investment in industrial fisheries has resulted in overfishing throughout Southeast Asia—in the Gulf of Thailand, demersal fish stocks in the 1990s had fallen to just one tenth of their levels in the mid-1960s when trawling began.[60] The depletion of inshore fish stocks has often come at the socioeconomic expense of small-scale fishers.[61] The disparity between industrial and small-scale sector catches has not been easily quantified due to inconsistent or lack of accounting of small-scale catches.[62]

55 UNCTAD, 2019.
56 FAO, 2018.
57 FAO, 2018.
58 FAO, 2020.
59 UN, 2010.
60 FAO, 1997.
61 Panayotou, 1980; Salayo *et al.*, 2006.
62 Teh and Pauly, 2017.

Resources in Southeast Asia have been fished down to 5-30 percent of their unexploited levels, which caused increased poverty among already poor coastal fishers (WorldFish, n.d.). Overfishing has also reduced the contribution of coastal fisheries to employment, export revenue, food security and rural social stability in these nations. Within small-scale fisheries, women play a "critical role in every link of the value chain," from production and processing to marketing and trade.[63] Women represent nearly half of the global fisheries workforce, yet their contributions to the industry remain invisible — particularly to researchers, managers, and policymakers.



The EAS region is the aquaculture hub of the world, but at a cost to ocean health and security. Instead of relieving fishing pressure, many global forage fish stocks and so-called "trash fish" can be overfished in an effort to derive fish oil and fish meal to feed farmed fish. There are also unresolved concerns with effluent discharge, the use of chemicals, disease transfer, and the destruction or alteration of important ecosystems, such as the destruction of mangroves to create farmed shrimp ponds, rice farms, palm oil plantations.

Another important issue that has not been properly discussed is that fisheries are highly energy intensive. Emissions from fishing vessel fuel use are the largest contributor to ocean and coastal fisheries-related GHG emissions. Between 1990 and 2011, emissions from global fishery industry increased by 28 percent.[64] Despite this significant contribution to global emissions, the full carbon footprint of fisheries — including supply chain emissions, such as transport, refrigerant loss and waste disposal — are often excluded from global GHG assessments. The Nationally Determined Contributions (NDCs) in the Paris climate agreement can serve as the entry point for governments to quantify and include non-fuel related emissions from motorized and non-motorized vessels as part of their national targets.

For all these reasons, the sustainability of fisheries is essential. Blue economy growth in the fisheries sector requires a central focus on ecological sustainability, disaster and climate resiliency, and inclusive development.

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63 FAO, 2015b.
64 Parker, R.W.R., Blanchard, J.L., Gardner, C. *et al.*, 2018.

4.5 Response Measures and Blue Economy Initiatives

Fisheries and aquaculture under the blue economy incorporates the natural capital in its development and throughout its production cycle as well as providing sustainable and decent employment, and high-valued commodities for exports (UNCSD, 2012). This sector provides a vital source of food and nutrition, jobs and livelihood, recreation, trade, and socioeconomic and ecosystem well-being for people throughout the world, both for present and future generations, and should therefore be conducted and managed in a sustainable and responsible manner. Policymakers and coastal and fishery resource managers are increasingly challenged by the need to ensure food security in the context of increasing human pressure on the marine environment and changing climate, and limited understanding of marine ecosystems and associated resources.

Some of the key policies, plans of action at the regional and national levels, and actions that have been undertaken are discussed below.

4.5.1 Addressing Overfishing

Country examples

RO Korea. RO Korea is implementing: (a) Total allowable catch (TAC) program as an output control, which regulates annual total amount of catch per species; (b) fishing permit and license; and (c) Vessel buy-back program to reduce fishing vessels and address overfishing.

The Korean government introduced the vessel reduction program in 1994. The government purchased a total of 18,955 vessels for KRW 1,558 billion from 1994 to 2014 under the Vessel Buy-back Program, most of which were nearshore fishing vessels. Nominal fishing effort has stabilized due to limited entry, but horsepower has increased, and fishing instruments have improved.

In 1998, the Korean government introduced the total allowable catch (TAC) program as an output control measure, which regulates annual total amount of catch per species. The TAC was a ground-breaking program to Korean fishing communities, which have been familiar with the input control measures, such as fishing permit, fishing license, and reported fishing, for over half a century.

Thailand. The Department of Fisheries has developed a **2015-2019 Fisheries Management Plan** recognizing the need to reduce the fishing capacity and fishing effort to limit the catch at or near the maximum sustainable yield (MSY), rebuild fisheries resources, eliminate IUU fishing, as well as prevent illegally fished commodity to enter Thailand seafood supply chain. For demersal fish, the specific capacity reduction targets for the Gulf of Thailand (GoT) and the Andaman

Sea are 40 percent and 10 percent, respectively. For pelagic fish, the proposed reductions were 30 percent in the GoT, and 20 percent in the Andaman Sea. The major measures include the removal of currently illegal commercial fishing vessels, imposing a series of temporal closures to fishing areas to relieve some fishing pressure, implementing the vessel monitoring system (VMS), and embracing the more holistic ecosystem approach to fisheries management. The Fisheries Management Plan also considers science-based management options, e.g., determining total allowable catch (TAC) and individual transferable quotas.

Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region

The series of regional technical consultations on neritic tunas conducted by SEAFDEC with its Member Countries identified the key issues that impede the promotion of sustainable utilization of neritic tunas in the Southeast Asian region. These include:

- insufficient data and information
- undetermined status of neritic tuna stocks
- open access system of the fisheries
- inadequate management of neritic tuna resources in some areas
- inadequate understanding of tuna management and conservation measures
- negative impacts of climate change on neritic tuna stocks
- negative impacts of fisheries on the marine ecosystem
- IUU fishing practices
- inadequate infrastructure in fishing ports and landing sites
- post-harvest losses and product quality deterioration
- inadequate intra-regional and international trade
- insufficient benefits to people involved in neritic tuna fisheries and industries
- inferior working conditions in fishing vessels
- absence of sub-regional action plans for neritic tuna fisheries
- insufficient information on status and trends of neritic tunas at sub-regional level
- limited support to intra-regional and international trade.

In an effort to address such issues and concerns, the SEAFDEC Member Countries adopted the *Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region* (SEAFDEC, 2015) with six (6) objectives and 16 Plans of Action as shown in **Table 4.12**.

Neritic tuna. *(Photo by SEAFDEC)*

Table 4.12: Important Features in the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the Asean Region.

Objectives	Issues and Concerns	Adopted Plan of Action
I. Determining available data and information, improving data collection and developing key indicators	1.) Insufficient data and information	1.) Improve data collection and analysis for neritic tunas
	2.) Undetermined status of neritic tuna stocks	2.) Assess neritic tuna stocks and develop resource key indicators
II. Improving sustainable fisheries management	3.) Open access system	3.) Promote management of fishing capacity
	4.) Inadequate management of neritic tuna resources in some areas	4.) Promote sustainable utilization of neritic tuna resources
	5.) Inadequate understanding of tuna management and conservation measures	5.) Enhance understanding of the management and conservation of measures of neritic tunas
	6.) Negative impacts of climate change on neritic tuna stocks	6.) Mitigate the impacts of climate change on neritic tuna stocks
III. Improving sustainable interaction between fisheries and marine ecosystem	7.) Negative impacts of fisheries on the marine ecosystem	7.) Reduce negative impacts of neritic tuna fisheries on the marine ecosystem
IV. Improving compliance to rules and regulations and access to markets	8.) Illegal, unreported and unregulated (IUU) fishing	8.) Combat IUU fishing in the Southeast Asian region
	9.) Inadequate infrastructures in fishing ports and landing sites	9.) Improve infrastructures in fishing ports/landing sites
	10.) Post-harvest losses and product quality deterioration	10.) Improve post-harvest techniques and product quality
	11.) Inadequate intra-regional and international trade	11.) Enhance intra-regional and international trade
V. Addressing social aspects	12.) Insufficient benefits to people involved in neritic tuna fisheries and industries	12.) Improve the benefits for people involved in neritic tina fisheries and industries
	13.) Inferior working conditions in fishing vessels	13.) Improve working conditions of labor
VI. Enhancing regional cooperation	14.) Absence of sub-regional action plans for neritic tuna fisheries	14.) Enhance and/or develop sub-regional action plans for neritic tuna fisheries
	15.) Insufficient information on status and trends of neritic tunas and sub-regional level	15.) Assess the status and trend of neritic tunas at sub-regional level
	16.) Limited support to intra-regional and international trade	16.) Enhance intra-regional and international trade

Source: Siriraksophon, S., 2017.

4.5.2 Ending IUU Fishing

a. International agreements and regional efforts

The *Port State and Flag State Measures Agreement to Prevent, Deter and Eliminate IUU Fishing* (PSMA), the *FAO Code of Conduct for Responsible Fisheries*, and improved monitoring, control and surveillance (MCS) are key tools in combating IUU fish, but there is far more work needed to address the issue.

Port State and Flag State Measures Agreement to Prevent, Deter and Eliminate IUU Fishing (PSMA). The PSMA has become a binding law as of 2016 among countries that have ratified the agreement (EAS members include Indonesia, Philippines, RO Korea, and Thailand). The PSMA seeks to stop fish pirates from "port shopping" for a safe haven, a practice where they can unload their illegal catch at ports with little oversight. Its provisions include a "denial of access to ports, port inspections, prohibition of landing, and detention and sanction, in order to prevent IUU fish from reaching national and international markets. Some countries have also decided to prohibit trade with countries that do not have port state measures in place. The PSMA also requires "the flag State to take certain actions, at the request of the port State, or when vessels flying their flag are determined to have been involved in IUU fishing…[even] over vessels flying their flags in areas beyond their national jurisdiction.

FAO Code of Conduct for Responsible Fisheries.[65] To promote long-term conservation and sustainable use of fisheries resources, following a call from the International Conference on Responsible Fishing (1992) to strengthen the international legal framework for more effective conservation, management and sustainable exploitation and production of living aquatic resources, the 1995 FAO Conference adopted the *FAO Code of Conduct for Responsible Fisheries*. The Code is voluntary and is to be interpreted and applied in conformity with international law. The Code sets out principles and international standards of behavior for responsible practices. It recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of all stakeholders of the fishing and aquaculture industries. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users.

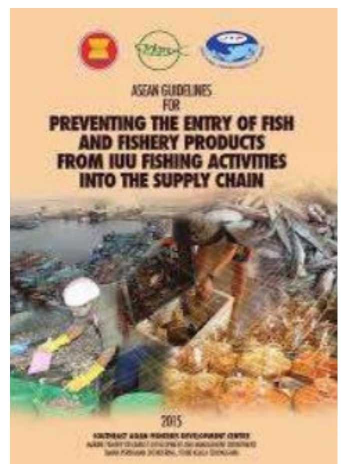
Monitoring, control and surveillance (MCS). This is a key component of fisheries management. It involves (a) monitoring, data collection and analysis of fishing and related activities (e.g., catch, species composition, fish stock and habitat assessment, fishing effort, by-catch, discards, area of operation, oceanographic conditions); (b) control measures (specification of the terms and conditions under which resources can be harvested, input and effort control, technical control and

[65] FAO, 1995.

regulations, and output control); and (c) fisheries surveillance and enforcement – before fishing, while fishing, during landing, and post-landing – to ensure that national legislation and terms, conditions of access, and management measures are observed.

ASEAN Regional Efforts in Fisheries Management and Combating IUU Fishing

- **Understanding current resource and management situation in the region.** Studies done to strengthen legislation.
- **Regional Plan of Action to Promote Responsible Fishing Practices including Combating IUU Fishing in the Southeast Asia Region**: A voluntary instrument endorsed by 11 Ministers Responsible for Fisheries in 2007.
- **Implementation of international and regional instruments**. Countries adopted their respective National Plan of Action to Prevent, Deter, and Eliminate IUU Fishing.
- **ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain**. The Guidelines were adopted in 2015, and an evaluation on the status of implementation of the Guidelines was undertaken in 2018-19. The key strategies and measures in the ASEAN Guidelines include:
  - Managing Fishing Activities within a ASEAN Member States
  - Regulating Transshipment and Landing of Fish / Catch across Borders
  - Preventing Poaching in the EEZs of ASEAN Member States
  - Controlling Illegal Fishing and Trading Practices of Live Reef Food Fish, Reef-based Ornamentals and Endangered Aquatic Species
  - Strengthening the Management of Fishing in the High Seas and RFMO Areas



- **Coastal State responsibilities, Flag State responsibilities, and Port State measures.**
  - Develop tools to fight IUU fishing – the Comprehensive of Global Record on Fishing Vessels, Refrigerated Transport and Supply Vessels
  - Update the IUU vessel list on RPOA –IUU website
  - Information exchange on IUU vessels
  - Preventing the IUU vessels accessing port's facilities
  - Develop procedure of listing and delisting IUU fishing vessels/vessel watch list
- **Regional market measures**. A workshop on the impacts of EC Regulation 1005/2008 on small-scale fisheries has been conducted.
- **Controlling transhipment at sea** (needs further discussion and elaboration)
- **Strengthening Monitoring, Control and Surveillance** (MCS).
  - Establish and develop the Regional and 3 Sub-regional MCS networks

  - Developing MCS communication procedures
  - Development public information campaign in the region as complement to MCS
- **Regional capacity building**. This includes training activities on Port Monitoring Techniques, and Port State Measures Agreement (PSMA); and developing the MCS curriculum.

ASEAN Catch Documentation Scheme (ACDS)

- Improvement of the traceability for capture fisheries toward the development of common regional catch documentation scheme/system: "ASEAN Catch Documentation Scheme (ACDS)"
- Concept note of the ACDS endorsed by 25th ASWGFi (May 2017)
- Objectives
  - Provide unified framework that will enhance traceability of fish and fishery products for effective management
  - Enhance the credibility of fish and fishery products for intra-regional and international trade
  - Prevent entry of fish and fishery products from IUU fishing activities into the supply chains.

Electronic Catch Documentation and Traceability System for Sustainable Tuna Fisheries

The Oceans and Fisheries Partnership (USAID Oceans) is funded by the United States Agency for International Development (USAID), working in partnership with the Southeast Asian Fisheries Development Center (SEAFDEC), Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security (CTI-CFF), and a wide range of public and private sector partners at regional, national, and local levels, to combat IUU fishing, promote sustainable fisheries and conserve marine biodiversity in the Asia-Pacific region.

An innovation being introduced and piloted in Bitung, Indonesia and General Santos City in the Philippines is the **Electronic Catch Documentation and Traceability System** (eCDT), which is the system of documenting key information about the harvest, processing, and transportation of a fisheries product electronically to enable traceability of the fish or seafood product through each step of its journey— from point of catch to the consumer's plate. Doing so electronically enables this information to be more quickly and easily captured, shared, and managed. The eCDT provides a practical way to:

- Ensure fisheries resources are legally caught and properly labeled.
- Encourage the collection and analysis of ecological and economic data throughout the seafood supply chain.
- Support effective national fisheries management and MCS.
- Comply with national, regional and international seafood regulations and import requirements.

b. National policies and action plans on IUU fishing

National governments are joining technology providers in casting wider transparency on illegal fishing activities. Examples from Indonesia and the Philippines are described below:

Indonesia. In June 2017, the head of Indonesia's Ministry of Marine Affairs and Fisheries made an "unprecedented move" by allowing Global Fishing Watch, a joint project of SkyTruth, Google and Oceana, to have access to all of the country's vessel monitoring system data. Only a few countries allow the public this level of access, but the Ministry Head "believes that making government fisheries data visible to the public is a powerful way to engage civil society in the fight against… IUU fishing."

Given Global Fishing Watch's standing offer to process and analyze these data for free, other East Asian countries may want to take them up on this unique offer to "leapfrog" and rely on free, cutting-edge technological services to tackle IUU fishing in their territorial waters.

Philippines. In the Philippines, a significant feature of the **Amended Fisheries Code, 2015 (RA 10654)** is the registration of fishing vessels, and installation of MCS system in "all Philippine flagged fishing vessels regardless of fishing area, and final destination of catch." There are many available technologies right now that can help the government and people in monitoring the behavior of fishing vessels. The MCS system would make it easier to ensure compliance with fisheries regulations. The use of these devices can show if commercial fishing vessels are operating in the right areas. This can help the artisanal fishers regain their municipal waters from encroachment by large fishing vessels.

Viet Nam. At the end of 2017, the Prime Minister issued *Directive No. 45/CT-TTg* on urgent tasks and solutions to overcome the European Commission's warning against IUU fishing, and following which, many coastal provinces have developed directives and plans for implementation. This is especially reflected in the promulgation of a **National Action Plan for Combating Illegal, Unreported and Unregulated (IUU) Fishing by 2025**, the establishment of the National Steering Committee for IUU Fishing, accession to the *United Nations Fish Stocks Agreement* and *FAO's Agreement on Port State Measures*, and the improvement of the legal system to ensure compatibility with international regulations on sustainable fisheries management.

4.5.4 Climate-Smart Aquaculture and Food Security

Advanced science and technological application will be one of the means to help the local aquaculture sector to reach targets for blue aquaculture development. To address some of the challenges, FAO has promoted policies to support innovative closed-loop aquaculture practices like aquaponics. There are also guidelines (e.g., documents developed by SEAFDEC) available to ensure safe and sustainable aquaculture, such as:

- Regional Guidelines on Traceability System for Aquaculture Products in the ASEAN Region
- Regional Policy Recommendations on Conservation and Management of Eel Resources and Promotion of Sustainable Aquaculture

a. Aquasilviculture and mangrove protection

Philippines. In the Philippines, the *Philippine National Aquasilviculture Program* (PNAP), implemented by the Bureau of Fisheries and Aquatic Resources (BFAR), together with the Commission on Higher Education (CHEd), is a program focused primarily on mangrove resource rehabilitation and livelihood provision to help address climate change, food security and poverty among municipal/artisanal coastal fisherfolks (Dieta and Dieta, 2015). Its goal and objectives are (1) replanting of destroyed mangrove resources; (2) establishment of community-based multi-species hatcheries (CBMSH), and (3) provision of aquasilviculture livelihood projects to fisherfolk beneficiaries covering 61 provinces and 71 state universities and colleges (SUCs) all throughout the country.

As of September 2013, around 31,000,000 out of 36,000,000 mangrove propagules have been planted. This represents 85 percent of the target for the said year, covering 10,000 ha throughout the country. For aquasilviculture, 76 percent has been attained, thereby benefitting almost 1,900 fisherfolk throughout the country. Almost 20 percent of participating SUCs has completed the establishment of CBMSHs while the others are still in the process of construction (Dieta and Dieta, 2015).

The ecosystems services of mangroves, such as habitat for diverse marine species, nutrient cycling, and waste assimilation, are benefiting the aquaculture farms, and in addition, provide shoreline protection and carbon sequestration services. Moreover, the multi-species farms will diversify and increase the income of fisher-beneficiaries.

Viet Nam. The Mangroves and Markets (MAM) project (conservation of mangroves based on sustainable shrimp farming and emission reduction) has been implemented in Ca Mau Province since 2012. MAM's model of organic shrimp farming in mangroves ensures that shrimp ponds must have 50 percent coverage of mangroves, the seed are of high quality and farming intensity should not exceed 20 shrimp/m^2/year. After three years of implementing Phase I (2013-2016) in Ca Mau, nearly 800 households have attained *Naturland certification*, and their shrimps have been paid for with high price by Minh Phu Seafood Group. More than 200 farming households also received *payment for mangrove forest management services*, totaling VND 300 million. There were 80 ha of mangrove forests that have been additionally planted in the area of shrimp farms by 402 farmers, to achieve the required 50 percent mangrove coverage in the farms. Furthermore, 12,600 ha of mangrove forest are protected from deforestation and 1,000 households were given support for building standard toilets.

Since 2016, Ca Mau has become a leading province in piloting the **payment for forest environmental services** (similar to the payment for ecosystem services concept) at VND500,000/ ha/year for contracted households. This is an income source to help the people while enhancing their responsibility in forest protection. It also helps in protecting the environment for shrimp-ecological forest farming, while improving livelihoods.

With the success of phase I, the Phase II project (2016-2020) was expanded to other provinces, such as Tra Vinh and Ben Tre. The hard clam aquaculture in Ben Tre, which resulted in increasing both mangrove areas and local incomes, has received certification from the Marine Stewardship Council (MSC).

b. Integrated multi-trophic aquaculture (IMTA)

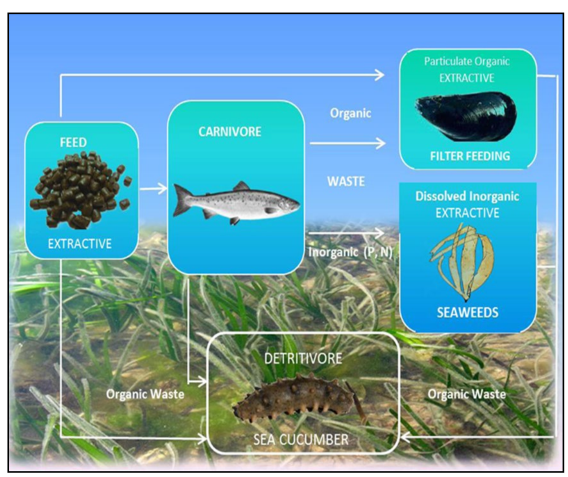
Dr. Kenneth Sherman (NOAA; Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems) commented that "The IMTA technology includes the production of algae (kelp), mollusks, (abalone) bivalves (bay scallop), and echinoderms (sea cucumber) to help close the fisheries protein gap, while capture fisheries recover to sustainable levels. Preliminary results suggest that the IMTA pilot should be expanded throughout the Yellow Sea Large Marine Ecosystem (YSLME) and into other Asian LMEs, where applications could provide job opportunities and food security. The pilot IMTA project in YSLME proved to be highly energy efficient and optimized the carrying capacity of coastal bays while improving water quality, increasing protein yields, and contributing to climate change mitigation through carbon capture."

The value of food provisioning service and climate/nutrient regulating service provided by the IMTA mode is much higher than in a monoculture (**Table 4.13**). IMTA also contributes to blue carbon – from the seaweeds/kelp and bivalve reef.

Table 4.13: Benefits of IMTA vs. Monoculture in Sungo Bay, China.

Mariculture mode	Net profit from sale (US$/ha/yr)	Value of climate regulating service (US$/ha/yr)
Kelp monoculture	7,238	715
Abalone monoculture	34,618	1,208
Abalone and kelp IMTA	47,876	1,999
Abalone, sea cucumber and kelp IMTA	71,164	2,034

Source: Liu et al., 2013; Guo, 2017.



IMTA structure from Fang et al., 2009.

Viet Nam. In Thanh Hoa province in Viet Nam, an integrated system is being piloted to cope with climate change through introduction of tilapia in brackishwater shrimp ponds. In this integrated system, tilapia can utilize natural food, and make use of feed residues from shrimp crop. This will result in clean shrimp ponds, reduction of feed conversion ratio (FCR) for farmed tilapia, and reduction of production costs.

Furthermore, brackishwater shrimp-rice rotation and forest-shrimp systems are being applied in the Mekong delta to reduce FCR, fertilizer use, and GHG emissions.

c. Ecological Pond Aquaculture

In May 2009, Dongying in China adopted the ICM Strategy, which included actions to achieve the dual objectives of developing the aquaculture industry and improving marine environment. The city then began transforming away from traditional pond aquaculture to *Ecological Pond Aquaculture*. Measures include reducing aquaculture pollution, strengthening safety control and seafood quality, enhancing seafood production sustainability, consolidating management and tracking, applying new technologies, building reputation and local brand, and increasing job opportunity and incomes.

d. Marine ranching

Marine ranching is a new form of production for maintenance and utilization of marine resources, based on marine ecology principles and modern marine engineering to make full use of natural productivity.

China. Marine ranching in Shandong Province resulted in:

- improved the marine ecosystem supply
- increased marine fishery production
- recovery of the function of marine ecosystem
- increased income of fishermen
- stable annual production of aquatic products

RO Korea. The marine ranching project in RO Korea consists of the establishment of model marine ranches and coastal water ranches. They were designed to improve income from fisheries and revitalize the economy of fishing communities by securing stable fishery productivity and systemizing the use and management of marine resources, taking into account the characteristics of each local area. The marine ranches involved:

- Installation of artificial reefs
- Release of fish seeds and aquatic species
- Marine afforestation and habitat restoration
- Removal of abandoned nets and materials
- Monitoring
- Database system made available to policymakers and fisherfolks

Lesson Learned in Sustainable Tuna Fisheries in the Context of the Blue Economy

1. Establish a framework for a sustained sub-regional collaborative governance coalition among the EAS countries. The GEF funds provided a catalysis for sub-regional governance of highly migratory tuna stocks; it would be advisable to sustain such a coalition, a joint voice representing EAS issues within the WCPO region.
2. Set clear, achievable, and measurable targets for progressing further towards achievement of sustainable tuna fisheries for blue economy in the EAS region of the WCPFC convention area. With varying definitions of the blue economy, it would be advisable for the EAS partners to agree upon a "roadmap" for progressing towards a blue economy.

To address gaps and major issues

3. Strengthen collaboration on certain technical activities. Cross-collaboration among the three beneficiary countries in EAFM, harvest strategy, climate change predictive and adaptive capacities, and risk assessment should be increased. This might be a more efficient use of project resources; it further cultivates sub-regional collaboration, and addresses the transboundary context of sustainable management migratory tuna stocks in the EAS.
4. Coordinate with the environment, agriculture, and fisheries agencies regarding strengthening climate change predictive and adaptive capacities, reducing bycatch of endangered, threatened, and protected species, and ecosystem conservation activities.
5. Develop and implement plan for increasing the capacities and involvement of subnational stakeholders. For example, the tuna fisheries value chain should be addressed in ICM processes. Mechanisms for enhancing food security for coastal communities should be put in place, such as securing a portion of allowable catch, requiring greater retention of bycatch from purse seine fishing operations, etc.

To scale up and replicate best practices

6. Establish collaborative partnerships with the private sector on application of market-based approaches.
7. Assess sustainable financing alternatives for maintaining adequate levels of data collection.

Source: PEMSEA and WCPFC, 2018.

Lessons Learned in Sustainable Fisheries and Aquaculture

- Invest in monitoring, control and surveillance systems as well as data collection, digitalization, and fish stocks assessment to make well-informed management decisions for more sustainable, and resilient fish stocks.
- Facilitate and support locally initiated efforts to improve coastal, small-scale fisheries, and promote those efforts at a higher level to ensure a broader impact.
- Improve scientific soundness of fish sanctuaries and MPAs, including their socioeconomic and ecological objectives, impacts and benefits, and enhance the management effectiveness of MPAs and MPA networks, thereby improving fish populations, generating more fish to be harvested outside the boundaries, and providing other ecosystem services, such as shoreline protection and climate change mitigation.
- Consider how land use policy and marine spatial plan can be oriented towards geographically appropriate, sustainable, and highly productive aquaculture, designation of MPAs, and delineation of small-scale fisheries and commercial fisheries.
- Promote technologies that will bring down production cost, and are technically appropriate, environmentally sound, and economically and financially viable.
- Reduce postharvest losses by providing fish landing centers and fish ports equipped with cold storage and ice production, and improving access to markets.
- Invest in a more vertically integrated supply chain that includes value-added processing to generate more wealth for locals (e.g., processing seafood and seaweeds).

For aquaculture

- No new aquaculture practices should be permitted in areas that are designated as MPAs or marine reserves. Conversion of mangroves, seagrass, and coral reefs into aquaculture farms must not be allowed; however, aquasilviculture may be permitted where viable.
- To reduce the pressure on stocks caught for fishmeal and fish oil, there needs to be a continued move towards sustainably produced feeds. Industry must expand its research and development on herbivorous and omnivorous fish, which have strong market potential and suitability for farming and plant-based feeds.
- Cultivation should be done with the right stocking densities to minimise the risk of disease outbreaks and transmission and, therefore, minimise requirements for therapeutic (antibiotic) treatments.
- To reduce nutrient wastes from aquaculture, there is great potential for the development of integrated multi-trophic aquaculture (IMTA) systems, aquaponics, integrated rice-fish culture, and aquasilviculture.

- Care must be taken in seaweed farming. Seaweeds are a particularly dangerous competitor of corals, as they typically grow much faster than corals and may contain nasty chemicals that injure the corals as well.

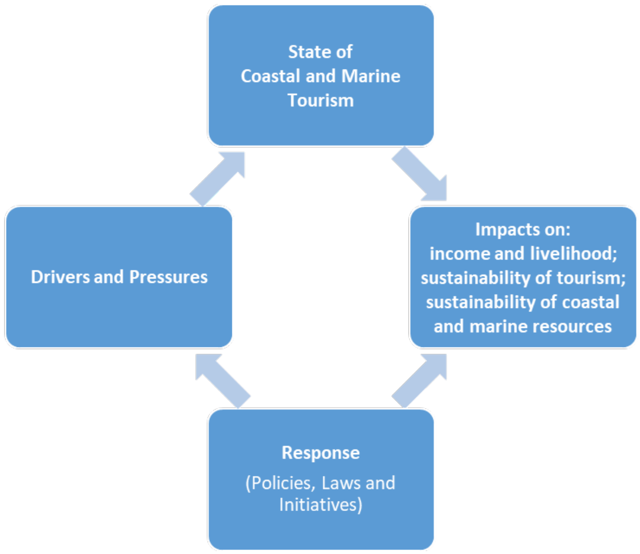
On climate change

- Offer government-supported disaster and climate insurance schemes that not only reinvigorate the sector but also promote greater cooperation of industry with government and communities.
- Incentivize fishing vessel and gear improvements to increase fuel efficiency and transition to low-carbon or zero-emission fishing vessels while limiting catch to sustainable levels.
- Explore the inclusion of fisheries in NDCs by determining and targeting emissions reductions from fisheries, aquaculture, and processing, as well as carbon sequestration from the seaweeds, coastal ecosystems, MPAs and marine reserves.

Artisanal fishers in Timor-Leste. *(Photo by A. Tilley)*

5 Marine and Coastal Tourism: Potential Force for Good

"Not all those who wander are lost."
J.R.R. Tolkien



SDG targets

- **Target 8.9**: By **2030**, devise and implement policies to promote **sustainable tourism** that creates jobs and promotes local culture and products (**Indicator 8.9.1**: Tourism direct GDP as a proportion of total GDP and in growth rate)
- **Target 12.b**: Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.
- **Target 14.7**: By **2030**, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture, and **tourism**.

Tourism is a vital tool for economic development and poverty reduction (UNWTO 2002). The coastal area, a source of biodiversity and ecosystem services, provides numerous opportunities for tourism and recreational activities, such as swimming, sunbathing, surfing, pleasure boating, etc. The open ocean also offers many opportunities for tourism and recreational activities that include SCUBA diving, sport fishing, sailing, whale and dolphin watching, and cruise tourism. However, the assessment of coastal and marine tourism – separate from the whole tourism sector – is not always available.

The tourism and recreation sector has direct economic as well as significant indirect and induced impacts. It promotes infrastructure development, such as road networks, airport and seaport facilities, and amenities in the coastal and beach zones, which have the potential to benefit the whole country and its local population. The tourism industry is an important source of direct and indirect employment. It creates opportunities for the development of small and medium scale industries. It helps spur the development of supporting infrastructure, such as hotels and resorts.

Tourism has become one of the most important sources of revenue for coastal communities, and much of the activities, such as boating, recreational fishing, bird watching, swimming, snorkeling, diving, and other water sports, are directly related to healthy ecosystems and clean coastal water. Tourism can be made to support conservation through private and public reserves, communal conservancies, contributions to MPAs, wastewater and solid waste management, and participation of tourists in coastal clean-up activities and habitat restoration. Ecotourism is becoming popular among environmentally-conscious tourists. Travel and tourism can be a form of education—through exploring new places and key biodiversity areas, learning about the natural and cultural heritage, and connecting with the people who live there.

Although tourism has immense potential to enhance socioeconomic development and contribute to environmental rehabilitation, it also has a wide range of negative social and environmental impacts. New approaches in shoreline management, marine spatial planning, water and energy efficiency, pollution reduction, and MPAs are needed to address environmental factors, as well as policy and regulatory frameworks to manage beaches, water quality, marine debris, and coastal and marine ecosystems more effectively for more sustainable and resilient tourism development.

Boracay (Photo by DENR Philippines)

5.1 Tourism and the Economy

Box 5.1. Total Contribution of Travel and Tourism

The **direct contribution** of Travel & Tourism to GDP reflects the 'internal' spending on Travel & Tourism (total spending within a particular country on Travel & Tourism by residents and non-residents for business and leisure purposes) as well as government 'individual' spending - spending by government on Travel & Tourism services directly linked to visitors, such as cultural (e.g., museums) or recreational (e.g., national parks). The total contribution of Travel & Tourism includes its 'wider impacts' (i.e., the indirect and induced impacts) on the economy.

Indirect Contribution. This measures the supply-chain impact or the inter-industry linkages for each sector. For the travel and tourism industry, its indirect contribution and impacts include utilities, financial services, resort development, furnishing and equipment suppliers, rental car manufacturing, ship building, aircraft manufacturing, transportation administration, security services, sanitation services, printing/publishing, tourism promotion, iron and steel, etc.

The 'indirect' contribution includes the GDP and jobs supported by:

- Travel & Tourism investment spending – an important aspect of both current and future activity that includes investment activity, such as the purchase of new aircraft or ferry, construction of new hotels.
- Government 'collective' spending, which helps Travel & Tourism activity in many different ways as it is made on behalf of the domestic purchases of goods and services by the sectors dealing directly with tourists – including, for example, purchases of food and cleaning services by hotels, of fuel and catering services by airlines, and IT services by travel agents.

Induced Impacts. This measures the impacts of incomes earned directly or indirectly as they are spent in the local economy. Induced impacts of tourism includes food and beverage supply, retailers, wholesalers, business services, housing, utilities manufacturers, computers, personal services, etc.

Source: World Tourism & Travel Council (WTTC)

According to WTTC (2016): Based on the direct, indirect and induced GDP impact, travel and tourism generated nine percent of Asia-Pacific's GDP in 2016. It is also projected that the travel and tourism sector would grow by 5.8 percent per annum (compound annual growth) over the next decade. In comparison, other sectors, such as mining and agriculture are forecast to grow

1.8 percent and 2.2 percent per annum, respectively, in real, inflation-adjusted terms. In 2016, travel and tourism continued to contribute a significant portion of the GDP of countries in the EAS region – from 5.1 percent of RO Korea's GDP to as much as 28 percent of Cambodia's GDP in 2016 (**Figure 5.1**). This is greater than the GDP contribution of other sectors, such as mining.

Figure 5.1: Percent Contribution of Travel and Tourism to GDP, 2006-2016.

Source: WTTC, 2016.

Travel and tourism generated, either directly or indirectly, 8.7 percent of Asia's employment in 2016.[66] This includes only those employees and the related value added of recreation, entertainment, accommodation, catering, transportation, and other related sectors. The tourism sector sustained a total of 159.2 million direct, indirect, and induced jobs in Asia in 2016, exceeding mining, automotive manufacturing, banking, and financial services sectors. Only the retail, construction, and agriculture sectors directly supported more jobs. However, for every job directly in the tourism sector, more than one additional job is created on an indirect or induced basis, making its linkages stronger than in the construction and agriculture sectors (WTTC, 2016).

[66] WTTC, 2016.

Table 5.1: International Tourism: Arrivals and Receipts (US$, 2009-2018).

Country	Number of Arrivals ('000)				Receipts (current US$ millions)				Receipts (% of exports)			
	2009	2012	2015	2018	2009	2012	2015	2018	2009	2012	2015	2018
Brunei Darussalam	157	92	218	278	254	92	140	190	3.1	0.7	2.1	2.7
Cambodia	2,162	2,663	4,775	6,201	1,463	2,663	3,411	4,832	29.5	30.0	25.7	26.2
China	50,875	50,028	56,886	62,900	39,675	50,028	114,109	40,386	3.2	2.3	1.9	1.5
Hong Kong SAR, China	16,926	37,098	26,686	29,263	20,291	37,098	42,601	41,870	5.3	6.5	7.0	6.1
Macao SAR, China	10,402	36,521	14,308	18,493	15,182	36,521	31,997	40,358	89.6	93.2	90.6	88.5
Indonesia	6,324	9,463	10,407	15,810	6,053	9,463	12,054	15,600	4.8	4.5	7.0	7.4
Japan	6,790	16,197	19,737	31,192	12,537	16,197	27,285	45,276	1.9	1.8	3.5	4.9
Korea, RO	7,818	18,731	13,232	15,347	13,289	18,731	19,126	19,856	3.0	2.7	3.0	2.7
Lao PDR	1,239	461	3,543	3,770	271	461	680	757	18.7	16.2	19.1	12.2
Malaysia	23,646	21,711	25,721	25,832	17,231	21,711	17,614	21,774	9.2	8.7	8.4	8.8
Philippines	3,017	4,963	5,361	7,168	2,916	4,963	6,418	9,730	6.7	7.4	8.9	10.8
Singapore	7,488	18,795	12,051	14,673	9,225	18,795	16,743	20,416	2.5	3.2	3.2	3.1
Thailand	14,150	34,565	29,923	38,178	19,811	34,565	48,527	65,242	10.9	12.6	17.6	19.9
Timor-Leste	44	21	62	75	16	21	51	78	24.2	20.4	56.0	64.0
Viet Nam	3,747	6,850	7,944	15,498	3,050	6,850	7,350	10,080	4.9	5.5	4.2	3.9

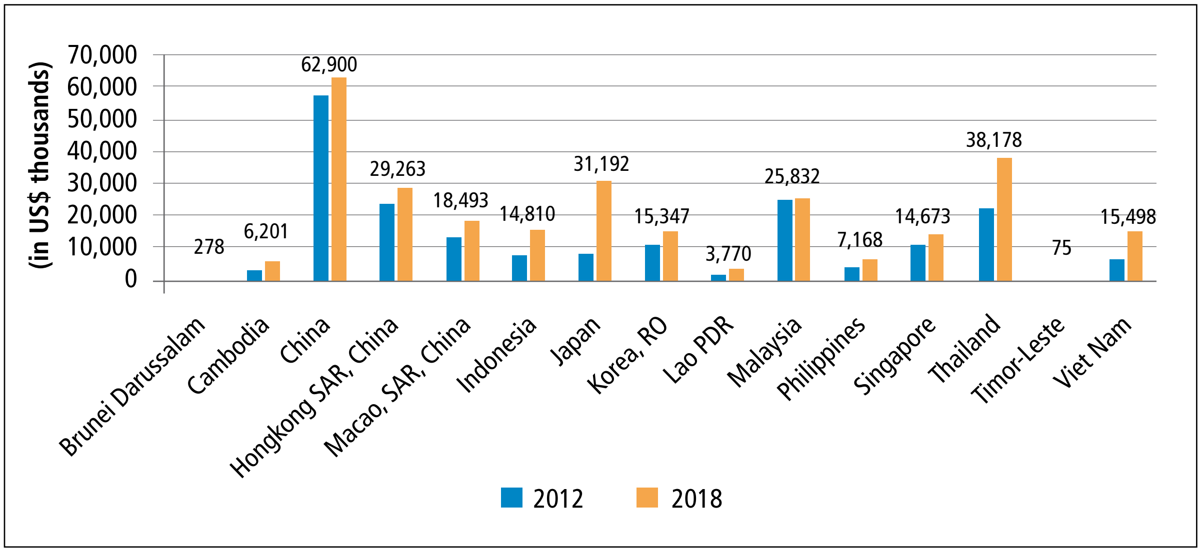
Source: The World Bank 2021; UNWTO, Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files.

In 2018, there were over 284.7 million international tourist arrivals to the EAS region, bringing in a total of US$ 336.5 billion in revenues to the countries in the region (**Table 5.1**). Majority of the international tourists went to China (22 percent), followed by Thailand (13 percent), Japan (11 percent), and Hong Kong SAR, China (10 percent).

There was an increase of 23 percent in the number of international tourist arrivals to the region between 2015 and 2018. However, the receipts declined by 3 percent, from US$ 348.1 billion in 2015 to US$ 336.5 billion in 2018. (**Figures 5.2** and **5.3**)

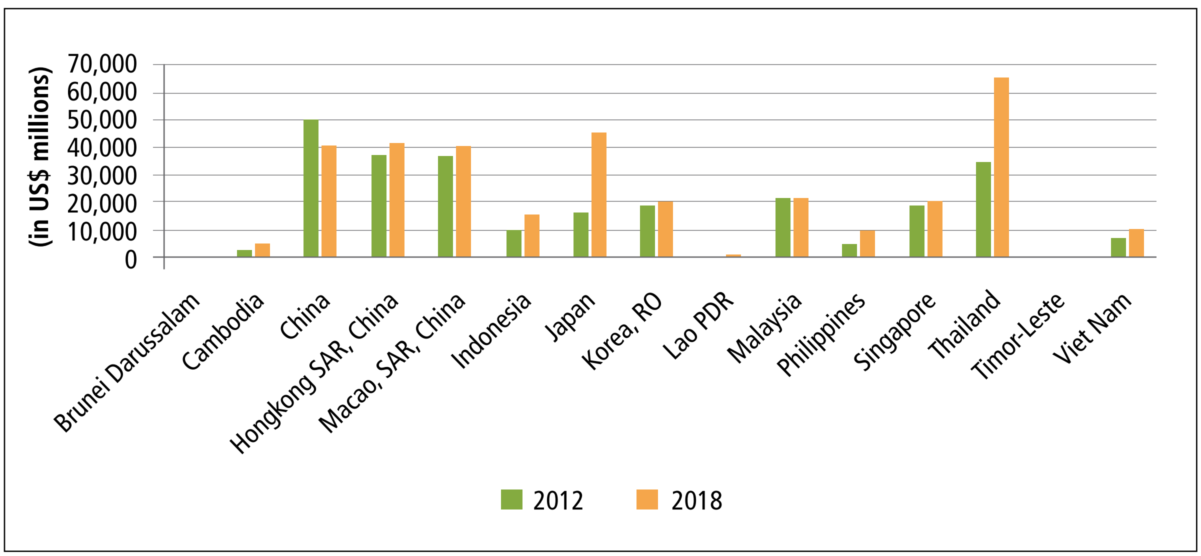
Coron, Palawan *(Photo by D.M. Bautista)*

Figure 5.2: Number of International Tourist Arrivals.



Source: World Bank, 2021

Figure 5.3: International Tourism Receipts (in US$ millions).

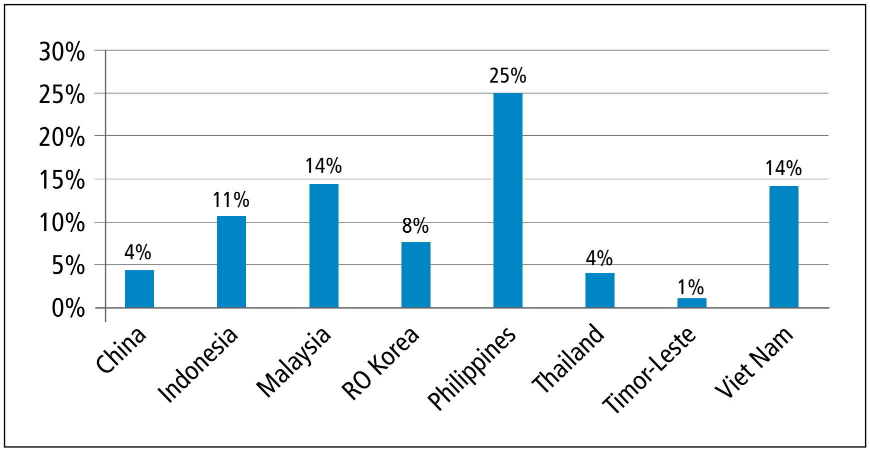


Source: World Bank, 2021

5.2 Coastal and Marine Tourism

A big share of the ocean economy is from the coastal and marine tourism sector (**Figure 5.4**)

Figure 5.4: Share of Coastal and Marine Tourism in the Ocean Economy.



Source: Various NSOC Reports.

Cambodia. The tourism industry has become a major revenue generator in Cambodia and is playing an important role in national development. Over the last decade, the number of visitors to Cambodia has increased rapidly, with an annual growth of between 10 and 15 percent. Currently, this sector is the third largest sector of Cambodia's economy after the agriculture and garment sector, and the second contributor of foreign earnings after the garment sector. There were 5,011,712 foreign tourists who visited Cambodia in 2016. Around 13 percent of foreign tourists visited the coastal areas, and 1.3 percent went to the ecotourism sites.

Indonesia. The total contribution of Travel & Tourism to GDP was IDR 787,100.0 billion (US$ 58.9 billion), or 5.8 percent of GDP in 2017.

The islands of Bali, Yogyakarta, and Jakarta are the main tourist destinations in Indonesia to date. As of 2017, 54 national parks have been established under the Ministry of Environment and Forestry (MOEF), with an area of 16,304,707 ha. Of the 54 national parks under MOEF, six are World Heritage Sites, and five are wetlands of international importance under the Ramsar Convention. National parks with official status as Marine National Parks (Taman Nasional Laut) are found in seven (7) locations, with a total area of 4,043,541 ha, and managed by MOEF. In addition, Ministry of Marine Affairs and Fisheries (MMAF) manages one Marine National Park (Taman Nasional Perairan), which is the Sawu Sea Waters National Park with an area 3,355,353 ha, as well as six Marine Nature Recreation Parks.

The number of foreign tourist arrivals and international tourism receipts more than doubled between 2010 and 2018. In 2018, international tourism receipts reached US$ 15.6 billion. The GVA of tourism increased by 16.9 percent from 2014 to 2015. The total GVA of tourism in 2015 was IDR 461.36 trillion (US$ 34.5 billion), contributing 4.23 percent of the total GDP.

The GVA of coastal and marine tourism and recreation in 2015 was **US$ 19.9 billion**.

Malaysia. The tourism industry in Malaysia has been expanding rapidly with visitor numbers increasing dramatically over the years. In 2018, tourist arrivals reached 25.8 million. This can be attributed largely to the rapid development of infrastructure, the constructive economy and well managed advertisement on the tourism sector focusing on heritage, forests, mountains, beaches, and islands. The total tourism revenues in 2018 amounted to **US$ 21.8 billion**.

Cruise tourism is another attraction for coastal and marine tourism in Malaysia and has become one of the National Key Economic Areas (NKEA). Ministry of Transport (MoT) coordinates the development of cruise tourism in Malaysia especially in the development of cruise infrastructure. The *Cruise and Ferry Integrated Seaport Infrastructure Blueprint for Malaysia* has been prepared as an outline for cruise tourism sector in Malaysia to achieve international standards. Current cruise terminals in Malaysia are located in Penang, Pulau Indah (Selangor), Kota Kinabalu (Sabah), and Langkawi Island (Kedah). A new cruise terminal was expected to be completely developed in Malacca by 2017.

Philippines. The total direct GVA of tourism was PhP 2.51 trillion in 2019 (US$ 52.3 billion), contributing 12.8 percent of the Philippine GDP in the same year. There were 5.8 million people employed in the tourism sector, representing 13.6 percent of total employment in the country.

The Philippine Statistics Authority (PSA) estimated the GVA of coastal and marine tourism in 2016 at **US$ 2.992 billion** (in constant 2012 prices), and there were 898,273 people employed in the coastal and marine tourism industry. (Only major beach destinations have been accounted for.)

RO Korea. In 2018, RO Korea had 19.9 million visitor arrivals, bringing in US$ 19.9 billion in receipts.

The GVA in coastal and marine tourism was US$0.38 in 2014, and US$0.35 billion in 2017 (MOF and PEMSEA 2019, and Chang 2021). The RO Korea government has adopted the *Second Basic Plan for Promotion of Coastal Tourism* (2014-2023). This is an action plan for the coastal tourism under the *Basic Plan for Marine and Fishery Development* based on the *Basic Act on Ocean and Fisheries Development* (BAOFD). The government has set two policy goals to achieve the vision of **Realization of Northeast Asian Marine Tourism Hub**. One is to reach a total of 500 million marine travel dates by 2023, and the other is to create 35,000 new jobs in marine tourism by 2023. To achieve these goals, the plan contains 17 detailed projects under five strategic divisions and a total of KRW3.3 trillion will be invested to carry out the projects.

Thailand. Major marine and coastal tourism sites are Phuket, Pattaya, and Ko Samui. The natural conditions of these sites attract many tourists each year. In addition, Thailand's marine national parks are popular tourist destinations because of the coral reefs. Coastal tourism in 23 coastal provinces contributed to about US$ 24 billion in 2015, and provided 820,713 people with employment in hotel and food sector in the coastal provinces (PEMSEA and DMCR 2019).

Timor-Leste. The tourism sector is one of the key economic development areas in Timor-Leste. The GVA of the marine tourism industry in 2015 was US$ 19.6 million, and it contributed one percent (1%) to the GDP. Around 43,000 people are employed in the marine tourism sector. Marine tourism is 56 percent of total tourism (PEMSEA and MAF 2019).

The Nino Konis Santana National Park is located in the eastern part of Timor-Leste. It is the country's first national park. Within the national park is a historical and heritage site called *Ili-kerekere*. Another site being promoted as tourist destination is the Nature and Parks in Maliana, which is among the protected areas targeted for rehabilitation and protection.

Viet Nam. The total direct revenue from tourists in 2017 reached VND 510,900 billion (US$ 22.6 billion), of which the tourism revenue of 28 coastal provinces and cities accounts for about 70 percent of total tourism industry revenue (PEMSEA, VASI and MONRE 2020).

The GDP of marine tourism in 2018 was estimated at VND 620,000 billion, which is 11 percent of GDP. The country currently has about 1.3 million workers directly serving in the tourism industry (accounting for 2.5 percent of the total labor force in the country).

Indonesia diver in Raja Ampat seascape. *(Photo by Fakhrizal Setiawan is licensed under CC BY-SA 4.0.)*

5.3 Pressures

Massive influxes of tourists, often to a relatively small area, can have huge social and environmental impacts. They add to the pollution, waste, and water needs of the local population, putting local infrastructure and habitats under enormous pressure. In many areas, massive new tourist developments have been built—including airports, marinas, resorts, and golf courses. Overdevelopment by the tourism industry has the same problems as other coastal developments, but often has a greater impact as the tourist developments are located at or near fragile marine ecosystems. The damage does not end with the construction of tourist infrastructure. Some tourist resorts discharge their sewage and other wastes directly into coastal waters surrounding coral reefs and other sensitive marine habitats. Recreational activities also can have a huge impact. For example, careless boating, diving, snorkeling, and fishing have substantially damaged coral reefs in many parts of the region, through people touching reefs, stirring up sediment, and dropping anchors. Marine animals, such as whale sharks, seals, dugongs, dolphins, whales, and birds are also disturbed by increased numbers of boats, and by people approaching too closely. Tourism can also add to the demand for and consumption of seafood in an area, putting pressure on local fish populations and sometimes contributing to overfishing. Collection of corals, shells, and other marine souvenirs—either by individual tourists, or local people who then sell the souvenirs to tourists—also has a detrimental effect on the local environment.

Box 5.2. Diving Sites in the EAS Region

The Sulu Sea in the Philippines is deep, with spectacular congregations of marine life found at diving sites, such as the remote Tubbataha Reefs. The popular dive sites of the Visayas region also fall within the Sulu Sea. Other dive spots are the sites in Balayan Bay in Batangas, and Puerto Galera in Oriental Mindoro along the Verde Island Passage, which is considered as the center of marine shore fish diversity (Carpenter and Springer 2005).

The Barracuda Point in Sipadan Island of Malaysia is considered as one of the best scuba diving spots in the world. Sipadan is located in the Celebes Sea off the east coast of Sabah. It was formed by corals growing on top of an extinct volcanic cone.

The greatest marine diversity is found in the Halmahera Sea in the North Maluku province of Indonesia, with 600 different species of coral and around 1300 fish species. Diving sites are at Raja Ampat and Fak-Fak in the Halmahera Sea. The Strait of Alor, Banda Islands and Ambon are among the excellent dive spots in the Banda Sea and Moluccas area.

The Similans, Mergui Archipelago and Pulah Weh are some of the great diving spots in the Andaman Sea.

5.4 Response: Sustainable Tourism for Blue Economy

Tourism can also support conservation through private and public reserves, communal conservancies, contributions to ICM and MPAs, and financing conservation programs. Ecotourism is becoming popular among environmentally-conscious tourists.

5.4.1 Sustainable Ecotourism Strategy

Malaysia

The *Malaysian Tourism Policy* was formulated in 1992, and ecotourism development started under the *National Ecotourism Master Plan* in 1996. Due to this Plan, a number of tourism destinations in Malaysia have been gazetted as protected areas either terrestrial or marine such as forest reserves, wildlife sanctuaries, wetlands, and marine parks. The Ministry of Tourism and Culture (MoTAC) coordinates the overall implementation of the Plan. Joint efforts between the government agencies, private sectors, and local communities have been carried out in order to ensure the success of the Plan. Efforts are given on the preservation of natural attractions to enhance ecotourism. Similar efforts are also given to historical sites, buildings, and artifacts in order to enhance heritage tourism in this country.

Club Med Cherating Beach in Pahang is a good example for ecotourism site in Malaysia. This resort has green features, provides nature education and conservation awareness for young tourists, and gives support for the Fisheries Department's turtle sanctuary initiatives.

Philippines

The Philippines has adopted the *National Ecotourism Strategy and Action Plan 2013-2022*. It aims to develop and manage globally competitive ecotourism sites, products and markets that will contribute to inclusive growth. The following are the key strategies:

Strategy 1: Developing and marketing diversified and competitive ecotourism products
Strategy 2: Creating conductive environment for ecotourism investments
Strategy 3: Maximizing economic benefits for the host communities
Strategy 4: Promoting and developing a culture of ecotourism
Strategy 5: Strengthening institutional capacity
Strategy 6: Developing and strengthening partnerships
Strategy 7: Establishing mechanisms for sustainable financing
Strategy 8: Monitoring outcomes and impacts

5.4.2 Best Practices in Sustainable Tourism

MPAs and ecotourism

Some of the MPAs in the Philippines have ecotourism programs, which generate revenues and create alternative livelihood while ensuring the protection of coastal and marine habitats and biodiversity.

One example is the **Cuatro Islas Protected Landscape and Seascape** in Leyte, Philippines. Taking into consideration the carrying capacity and environmental impacts, visitors to Cuatro Islas have been limited to 500 persons per day, with recommendations being considered by the local government to improve waste management, limit snorkelers to 200 per day, control the entry of boats to the island at 20 boats per day, and strictly use designated docking areas and mooring zones for cruise ships to mitigate reef destruction.

Community-based ecotourism

In Timor-Leste, *dugong* and seagrass conservation is being developed to become a model of ecotourism. Community-based ecotourism is also being promoted as it brings an alternative source of income and livelihood. This type of tourism aims to develop locally-run hotels and restaurants employing local people, and offering local products, thereby increasing income, creating new employment opportunities, and increasing demand for fresh produce.

Zero Carbon Resort (ZCR) For Sustainable Tourism Program

Philippines. During the initial phase of the **Zero Carbon Resort (ZCR) For Sustainable Tourism Program** from 2009 to 2014, over 500 tourism establishments in the Philippines joined the program and were given capability workshops on the following topics: energy, water, and resource management; 3R (Reduce, Replace, Redesign). Three of the ZCR first phase participants – Daluyon Beach and Mountain Resort in Palawan, The Manor at Camp John Hay in Baguio City, and Amarela Resort in Bohol – got recognition during the ASEAN Green Hotel Awards from 2014 to 2016. The second phase is ongoing.

The benefits accruing to 297 sampled companies include: accumulated annual savings amounting to US$8,636,208.76; a reduction in energy of 38 MWh; 714,427,966.30 liters of water saved; and avoided 23,348,538.52 kg of carbon emissions.10 This project thus builds the case that making businesses more sustainable do not just make economic sense, but also significantly reduces its carbon and water footprint, ensuring long-term growth and resilience.

Thailand. The accumulated annual savings of 23 companies that participated in the ZCR initiative is **US$ 828,612**. These resorts were able to offset the energy consumption equivalent to 15,068 households, and the water consumption of 183 homes. The annual fuel consumption avoided is equivalent to 157 cars, while the avoided carbon emissions offset 1,554 vehicles.

The Ko Mak Low Carbon Destination Project in Trat Province in Thailand is of particular interest. The objective of this project is to reduce carbon footprint, reduce pollution, and maintain and improve the environment. Thailand's first "Low Carbon" destination, Ko Mak was launched as a special area for sustainable tourism development. To lower emission of carbon dioxide and pollutants in the island, locals are urged to use alternatives to petroleum-based fuels, implement water and waste management, and preserve local activities and the traditional way of life. For tourists, the island offers environmentally friendly activities, such as cycling, kayaking, and sailing. Moreover, business operators are now using fresh groceries, avoiding all polluting products.

Green Fins Program

Green Fins, internationally coordinated by Reef-World, are the only recognized environmental set of standards with a comprehensive management approach to provide guidance and support for business owners and national authorities to promote best practices. Diving and snorkelling centres are uniquely positioned to act within their own communities and among customers to encourage positive and lasting change. Assessments are carried out and those showing annual improvement in following the Code of Conduct are awarded certificates, allowing tourists to choose environmentally responsible options.[67] The countries working with Green Fins include Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam.

In Viet Nam, the Green Fins Programme is replicated in Nha Trang (Khanh Hoa), Cu Lao Cham (Quang Nam) Quang Binh and other localities with key diving sites and coral reefs.

The Green Fins Programme in Thailand is implemented by Phuket Marine Biological Centre, and supported by DMCR. It involves capacity development and assessment of SCUBA diving and snorkeling establishments to ensure that they are minimizing their environmental impacts. Dive operators are required to undergo training and follow Code of Conduct. Green Fins members formed a network for protection and sustainable use of coral reefs. They also help with the monitoring of coral reefs during dive trips.

Beach management and setback zoning

Under the ICM program, PEMSEA and Cambodia's Ministry of Tourism addressed the following issues in Occheateal Beach: low levels of tourism, coastal erosion, polluted beach front, and

[67] Green Fins. Downloaded from http://greenfins.net/en

effluent discharge – through beach management plan and coastal use zoning scheme. Key results include: tourism quadrupled in just a few years after relocating commercial stall owners a little farther from the shore; increased income for stall owners; reduced environmental impacts. These benefits inspired the National Government to adopt zoning schemes throughout the country and land-use plans for the sustainable development of coasts, beaches, rivers and islands.

Wastewater management and coral reef restoration

In Indonesia, by the late 1990s, the eroded beach in the Denpasar region of Bali had become heavily polluted from untreated sewage. Coral reefs—one of the biggest draws for tourists—were dying and covered in harmful green algae because of the excess nutrients in the water. Two programs addressed the issues of wastewater management and coral restoration. The ICM program created public awareness on the wastewater issue, and a subsequent survey gauged the public's willingness to pay for improved wastewater management. A sewage treatment system was constructed with a loan from Japan. The National Program on Coral Reef Destruction Mitigation (2004) incorporated coral transplantation along with the creation of new diving sites—tourists actually paid to transplant the coral themselves (purchased from nearby communities' coral nurseries), and this concept generated more income for all communities involved. Also, there was a strong enforcement angle that was a prerequisite for true results to control pollution in coastal waters, and to ensure that the coral rehabilitation project would not be in vain.

Conservation finance

There are several studies conducted in Thailand on financing mechanisms to fund conservation. The fundamental principle emphasized in these studies is how to make the tourism sector pay more than the financial cost of visiting the sites. The studies demonstrated that there is willingness to pay and contribute to the conservation of iconic marine endangered species and protection of their habitats, including those outside the MPAs (PEMSEA 2015; Orapan and Nawarat 2015). Examples of financing mechanisms include island visitor fee, scuba diving fee, and hotel surcharge. The potential to introduce Payment for Ecosystems Services (PES) is being explored in one of the most popular island destination sites in the Gulf of Thailand.

The Marriott Hotel in Thailand signed a three-year Memorandum of Understanding (MOU) with IUCN. Customers at its two hotels in Thailand are encouraged to donate $1 for each overnight stay to IUCN towards its mangrove restoration project.[68]

In Batangas, Philippines, the Environmental User Fees (EUFs) are collected in the diving sites and beach resort areas. The collected fees are used to support the Bantay Dagat (sea watch) program for monitoring illegal fishing, and other coastal resource management projects.

[68] IUCN-MFF, 2016.

A Conservation Charge is imposed on visitors to Marine Parks of Malaysia. This is in accordance to Fee Act 1951, Fee Order (Marine Park Malaysia) 2003. Collection of the charge is credited in Marine Park and Marine Reserve Trust Fund. The fund is used for management purposes and to provide basic facilities for visitors at the Marine Park Centres. However, exemption is given to all population who live on the islands surrounded by Marine Parks.

Lessons Learned in Sustainable Tourism

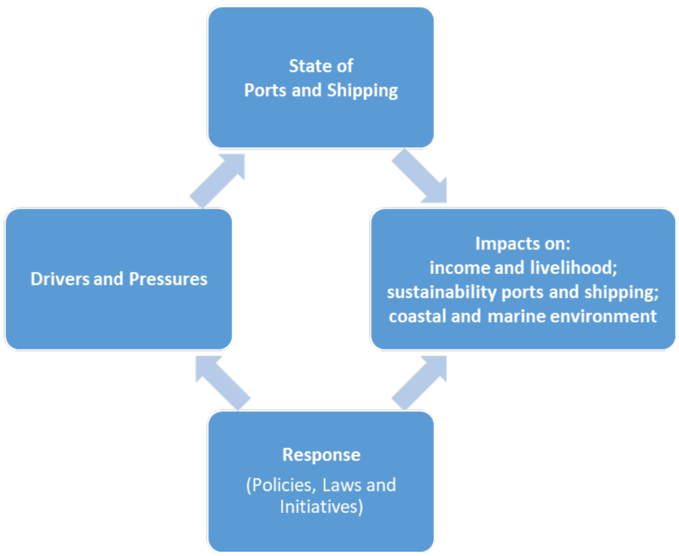
- Formulate and apply specific criteria that address sustainability, informed by existing third-party certification standards, to promote businesses that truly represent these values.
- Scale up ICM programs with a particular focus on conservation of coastal and marine resources, sustainable tourism and ecotourism, and sustainable development of coastal communities.
- Develop and implement policy instruments, MSP/coastal use plans, regulations on waste management and habitat protection, and planning and licensing processes to prevent uncontrolled shoreline development and resource-use conflicts, avoid pollution and degradation of coastal ecosystems, and ensure public accessibility.
- Undertake deliberative, inclusive planning before embarking on any tourist-related development. Embed a long-term vision of sustainability among local governments, coastal communities, and local businesses.
- Invest in, operate and sustain solid waste and wastewater management systems that protect water quality and maintain healthy and resilient coastal and marine resources, in partnership with the tourism industry and local businesses benefiting from tourism. Advance the reduction of plastic use, proper disposal of solid waste, including recycling, and reuse of treated wastewater for non-potable uses.
- Promote and incentivize hotels, resorts, and other tourism establishments to reduce their carbon and water footprints and plastic use, and show the returns to their investments in improving resource use, and reducing wastes and GHG emissions. Encourage their participation in the Green Hotel Awards, sustainable building certification, etc. to improve efficiency and corporate social and environmental responsibility.
- Manage MPAs to effectively protect and conserve the very natural resource that draws tourism, and ensure capable and adequate human resources, facilities and funding mechanisms are in place to sustain operations. Partner with tourism establishments to support the financing and management of MPAs, habitats, key biodiversity areas and natural heritage sites.

Labuan Bajo pier (Flores, Indonesia) at sunset *(Photo by Jorge Lascar, CC-BY-2.0)*

Qingdao Pier, China *(Photo by M. Ebarvia)*

6 Ports and Shipping: Heroes of Globalization and Connectivity

"The sea, the great unifier, is man's only hope.
Now, as never before, the old phrase has a literal meaning:
we are all in the same boat."
Jacques Yves Cousteau



Maritime transport is the backbone of international trade and the global economy. According to UNCTAD (2019) around 80 percent of global trade by volume and over 70 percent of global trade by value are carried by sea and are handled by ports worldwide, while according to OECD,[69] around 90 percent of traded goods are carried over the waves.

The EAS serve as an important conduit of world trade and travel. This comes with opportunities and challenges.

[69] OECD 2019. Ocean shipping and shipbuilding. (https://www.oecd.org/ocean/topics/ocean-shipping/)

Sustainable ports and shipping contribute to the achievement of the SDGs, in particular:

- **SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**
  - **Target 9.1**: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
    - ◊ **Indicator 9.1.2**: Passenger and freight volumes, by mode of transport
  - **Target 9.4**: By **2030**, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
- **SDG 8: Decent work and economic growth**
  - **Target 8.4**: Improve progressively, through **2030**, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation…
- **SDG 12: Ensure sustainable consumption and production patterns**
  - **Target 12.4**: By **2020**, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
  - **Target 12.6**: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
- **SDG 11: Sustainable cities and communities**
  - **Target 11.2**: By **2030**, provide access to safe, affordable, accessible and sustainable transport systems for all…
- **SDG 13: Take urgent action to combat climate change and its impacts**
- **SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development**

Ports are gateways that link goods transported by sea to markets and people to coastal destinations, and constitute an important economic activity in coastal areas. The higher the **throughput of goods and passengers year-on-year**, the more infrastructure and related services are required. Liner services by container, cruise ships, and RO-RO carriers allow connectivity on a global scale, and people and communities to interact with various cultures around the world. These will bring varying degrees of benefits to the economy and to the country.

Facilities and infrastructure built around port areas contribute to raising the standard of living of the residents in the vicinity of the seaports. The region features some of the world's busiest and most strategic shipping routes serving much of the maritime trade between East Asia, Southeast Asia, and South Asia, Persian Gulf, Africa, Europe and the Americas. Seaports facilitate trade of manufactured products, raw materials and commodities, as well as development of trade centers and industrial zones, which, in turn, create jobs and business opportunities.

Passenger ports and terminals include facilities for ferry docking, cruise ship departures and arrivals, as well as marinas for recreational boats and pleasure crafts. They service passengers boarding and leaving water vessels, such as ferries, cruise ships and ocean liners. Some passenger ports have facilities for automobiles and other land vehicles to be picked up and dropped off by the water vessels. This growing and highly competitive market can be very capital intensive.

Ports also generate supporting activities, such as transportation and construction. The ocean industry in the region has expanded beyond just maritime trade to include service-based activities. Ocean ancillary services, such as logistics, banking, insurance, maritime law, bunkering, crewing, monitoring of maritime traffic, and information technology, provide essential support to the operations of ports and shipping, which serve as the conduit for much of the region's trade.[70] Thus, ports provide significant benefits to the host port cities as well as contribute billions of dollars to the local and national economies.

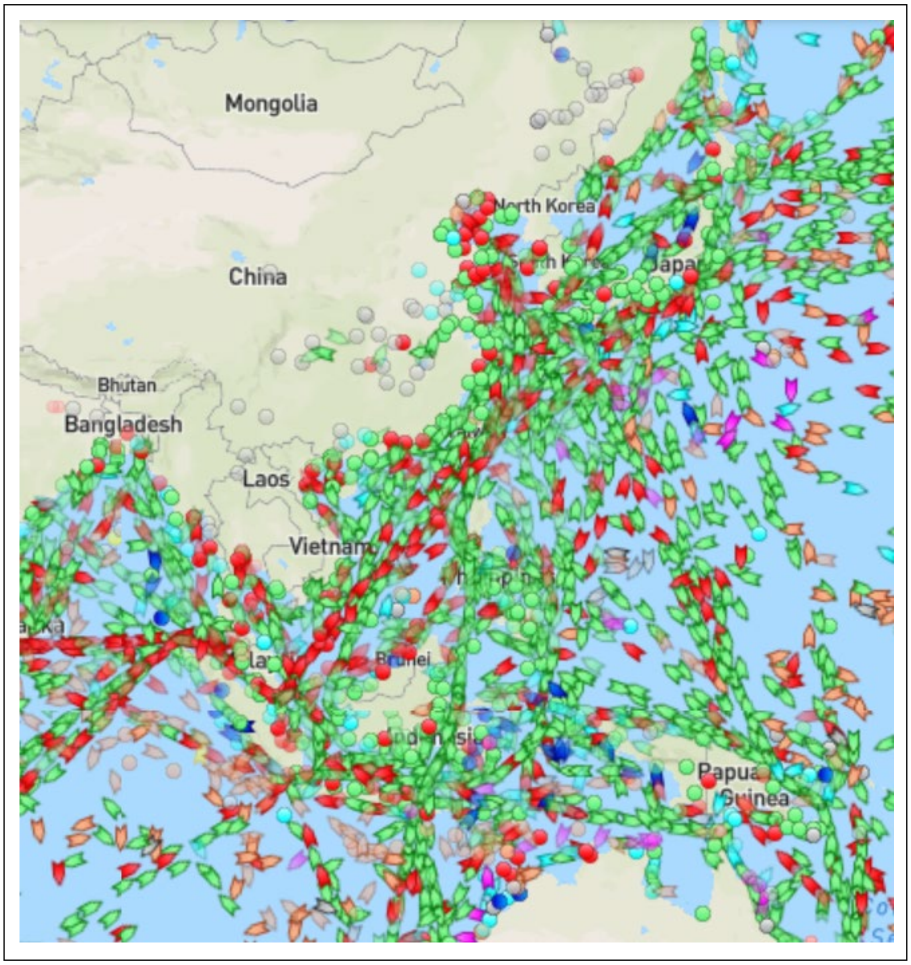
Maritime ships include cargo and container ships, oil tankers, cruise liners and ferries; fishing vessels; yachts and pleasure crafts; merchant and research vessels; coast guard, military, and other government-operated ships; and a growing fleet of automated surface vessels. Real-time information on the movements of ships (those fitted with automatic identification system or AIS) and the current location of ships in harbors and ports are available on several website platforms. Vessel maps are available like the map in **Figure 6.1**. A database of vessel information includes for example details of the location where they were built plus dimensions of the vessels, gross tonnage and International Maritime Organisation (IMO) number. The IMO Convention for the Safety of Life at Sea (SOLAS) requires AIS to be fitted aboard international voyaging ships with 300 GT or more, and all passenger ships regardless of size.

The huge demand for shipping services to support growing intra-regional and world trade, travel, and increasing offshore activities has been a boon to the shipbuilding and ship repairing industry in the region. Many shipyards in the EAS region have upgraded their capacity and expanded their business, while new ones have been built to meet the demand for merchant vessels.

However, most of the ports are situated at an interface between land and sea, and connected to rich habitats (e.g., seabed; estuarine waters; mudflats; wetlands; mangroves; seagrass beds;

[70] Ebarvia, 2016.

Figure 6.1: Marine Vessel Traffic in the EAS Region (2021).



Legend: **green**: cargo ship; **red**: tanker; **orange**: fishing vessel; **purple**: pleasure craft; **dark blue**: passenger vessel; **light blue**: tugs and special craft
Source: https://www.marinetraffic.com/

coral reefs). Some of these ports are directly on the shore, established on reclaimed land and the surrounding seabed, or located along the banks or mouths of rivers. These sites are connected to habitats, which are at risk from port operations as well as from accidental oil and chemical spills. Problems, such as safety of port operation and storage of goods, safety of industrial processes, safety of ships, and management of soil contamination, water pollution, solid waste, marine debris, ballast water and invasive alien species management, and marine biosafety, must be addressed by the ports and shipping sectors. Although shipping currently accounts for 2.6 percent of total GHG emissions, this could more than triple by 2050 as demand for global freight increases, and maritime trade volumes position to triple to 2050.[71]

[71] OECD. Ocean shipping and shipbuilding. (https://www.oecd.org/ocean/topics/ocean-shipping/)

Specific activities of ports towards environmental stewardship include environmental management for existing and new facilities, measuring and reporting on continuous improvement in environmental performance, addressing community concerns, such as human health, environment and quality of life, and responding to climate change.

Currently, safety and emissions regulations, and higher energy prices are the major factors changing the shipping industry. New technologies, new fuels, new engines, and new designs are becoming available. The challenge for ship-owners, shipbuilders, equipment and machinery manufacturers, and financiers concerns more with what technology to choose and when to invest considering price and market volatilities.

6.1 Navigational Lanes and Shipping Traffic

6.1.1 Straits of Malacca[72]

From an economic and strategic perspective, the Strait of Malacca is one of the most important shipping lanes in the world. The strait is the main shipping channel between the Indian Ocean and the South China Sea, and links major Asian economies, such as China, Japan, South Korea and India.

About a quarter of all oil carried by ships passes through the Strait, mainly from Persian Gulf suppliers to the Asian markets. Nearly one-third of the 61 percent of total global petroleum and other liquids production that moved on maritime routes in 2015 transited the Strait of Malacca, the second-largest oil trade chokepoint in the world after the Strait of Hormuz.[73] This Strait is the primary chokepoint in Asia, with an estimated 16.0 million barrels per day (b/d) flow in 2016, compared with 14.5 million b/d in 2011 (**Table 6.1**). The Strait of Malacca is also an important transit route for liquefied natural gas (LNG) from Persian Gulf and African suppliers, particularly Qatar, to East Asian countries with growing LNG demand. The biggest importers of LNG in the region are Japan and South Korea.

Moreover, it is also one of the world's most congested shipping choke points because it narrows to only 2.8 km (1.5 nautical miles) wide at the Phillips Channel of the Singapore Strait. This natural bottleneck creates the potential for collisions, grounding, or oil spills. The maximum size of a vessel that can pass through the Strait is referred to as *Malaccamax*. If the Strait of Malacca were blocked, nearly half of the world's fleet would be required to reroute around the Indonesian archipelago (**Figure 6.2**). Such rerouting can lead to increased shipping costs, which can potentially affect

[72] The information in this section is from: U.S. Energy Information Administration (EIA). 2017. "World Oil Transit Chokepoints."

[73] U.S. Energy Information Administration (EIA) 2017. "The Strait of Malacca, a key oil trade chokepoint, links the Indian and Pacific Oceans"

energy prices. In addition to the potential for accidents and oil spills, piracy, including attempted theft and hijackings, is a threat to tankers and seafarers in the Strait of Malacca, according to the International Maritime Bureau's Piracy Reporting Centre.

Table 6.1: Strait of Malacca Oil and Liquefied Natural Gas Flows, 2011-2016.

	2011	2012	2013	2014	2015	2016
Total oil flows (millions b/d)	**14.5**	**15.1**	**15.4**	**15.5**	**15.5**	**16**
crude oil	12.8	13.2	13.3	13.3	13.9	14.6
refined products	1.7	1.9	2.1	2.2	1.5	1.4
LNG (Tcf per year)	**2.8**	**3.5**	**3.9**	**4.1**	**3.6**	**3.2**

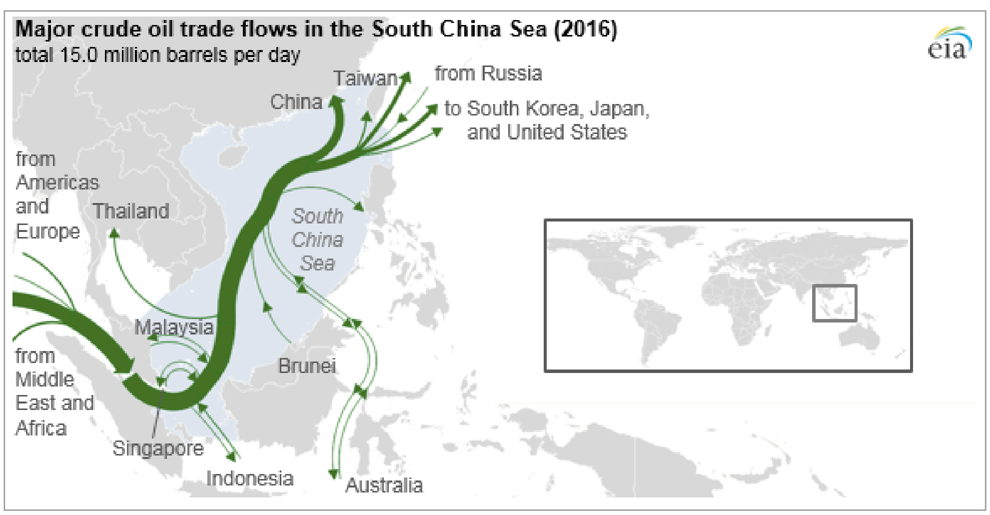
Notes: b/d = barrels per day; Tcf = trillion cubic feet
Source: US Energy Information Administration[74]

Vessels navigating in the Straits of Malacca and Singapore are required to comply with the 'Rules For Vessels Navigating Through the Straits of Malacca and Singapore' adopted by the IMO Maritime Safety Committee 69 in 1998, in accordance with the provision of Resolution A.858(20).

6.1.2 South China Sea[75]

The South China Sea is an extremely significant body of water in a geopolitical sense. It is the second most used sea lane in the world and is a major trade route for crude oil. In 2016, more than 30 percent of global maritime crude oil trade, or about 15 million barrels per day (b/d), passed through the South China Sea. The three crude oil importers with the largest volumes passing through the South China Sea—China, Japan, and South Korea—collectively accounted for 80 percent of total crude oil volumes transiting the South China Sea in 2016.

Figure 6.2: Crude Oil Trade Flows in the South China Sea.



Source: U.S. Energy Information Administration (EIA), based on Clipper Crude Data Service and IHS EDIN

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[74] US EIA analysis based on: Lloyd's List Intelligence, Analysis of Petroleum Exports (APEX) database; IHS Waterborne (May 2017); and BP, Statistical Review of World Energy 2017 (June 2017).
[75] The information in this section is from: U.S. Energy Information Administration (EIA) 2018.

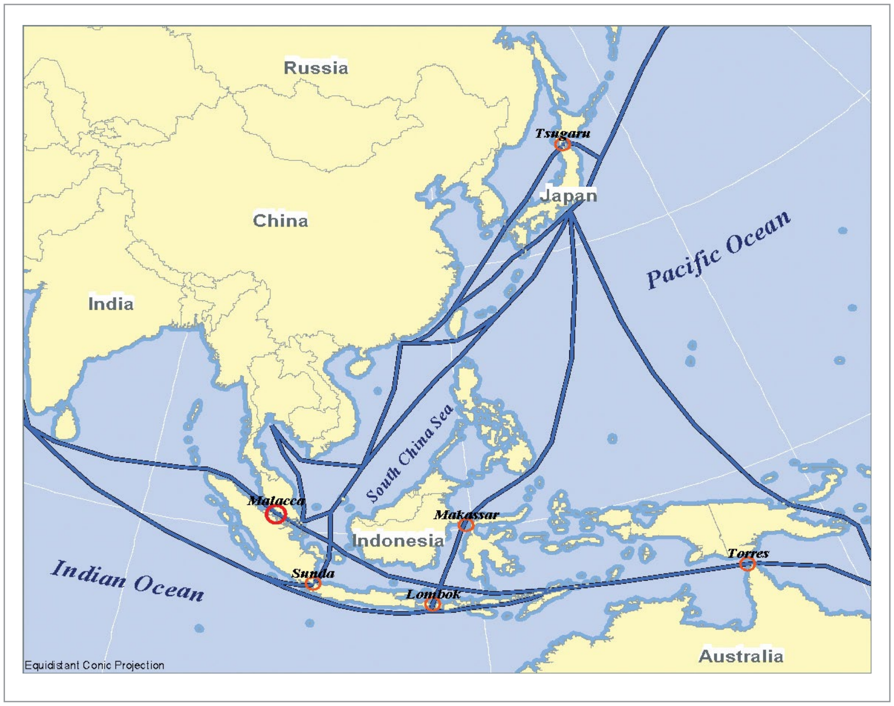
The South China Sea is a major trade route for the Middle East, which accounted for more than 70 percent of total South China Sea crude oil shipments in 2016. In addition to Middle Eastern and North African volumes, some regional countries bordering the South China Sea contribute to the overall shipments of crude oil through the region. Indonesia and Malaysia together accounted for five percent of crude oil loadings that passed through the South China Sea in 2016 and two percent of crude oil receipts. Singapore accounted for two percent of crude oil loadings that passed through the South China Sea in 2016 and one percent of crude oil receipts. Although Singapore does not produce crude oil, it is a major hub for refining crude oil and for storing and transshipping crude oil and petroleum products. In 2016, 95 percent of Singapore's crude oil exports passed through the South China Sea.

Most of the crude oil from these countries that passes through the South China Sea is exported to other countries. However, some intra-country trade also crosses the southern portion of the South China Sea as cargoes move between eastern and western ports within each country.

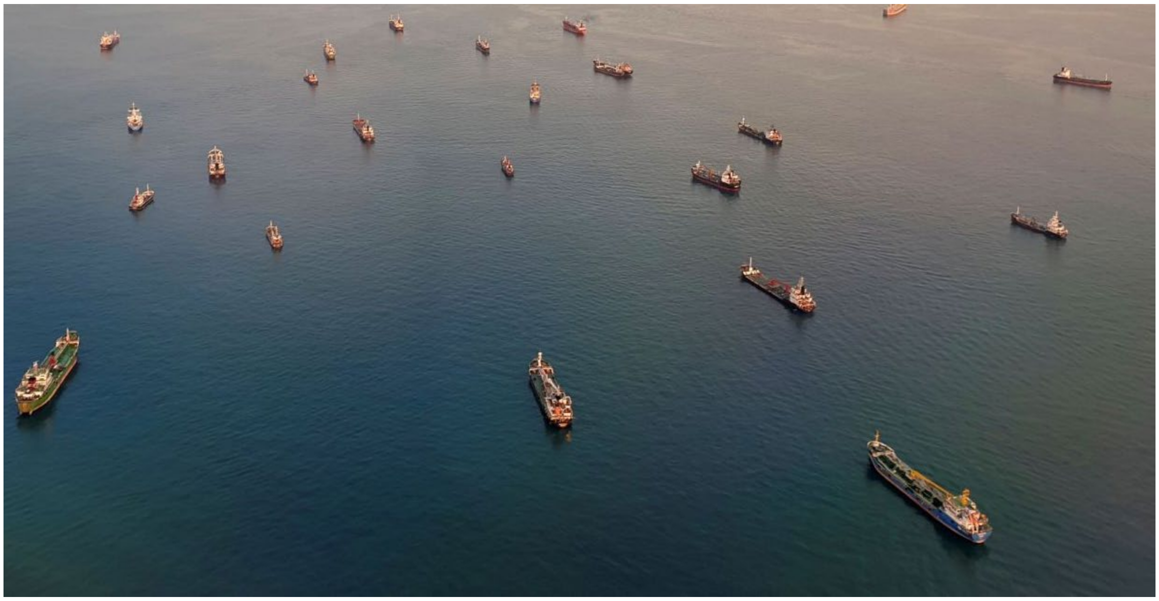
6.1.3 Other Important Sea Lanes in the EAS Region

For some of the world's largest ships, mostly oil tankers, the Strait of Malacca's minimum depth (25 m) is not deep enough. The next closest passageway, the *Sunda Strait* between Sumatra and Java is even more shallow and narrow than the Strait of Malacca. Therefore, these large ships must detour several thousand kilometers, and use the alternate routes of going through the Lombok Strait, Makassar Strait, Sibutu Passage, or Mindoro Strait instead (**Figure 6.3**).

Figure 6.3: International Shipping Lanes in the EAS Region.



Source: UNCTAD.



Strait of Malacca (Photo by International Register of Shipping)

6.2 Performance of Ports and Shipping

6.2.1 Quality of Ports

It is important for developing countries to continuously improve the quality of port infrastructure as it contributes to better logistics performance, leading to more trade, and higher economic growth. The **Quality of Port Infrastructure** measures business executives' perception of their country's port facilities.[76] Scores range from 1 (port infrastructure considered extremely underdeveloped) to 7 (port infrastructure considered efficient by international standards). Respondents in landlocked countries were asked how accessible the port facilities are (1 = extremely inaccessible; 7 = extremely accessible).

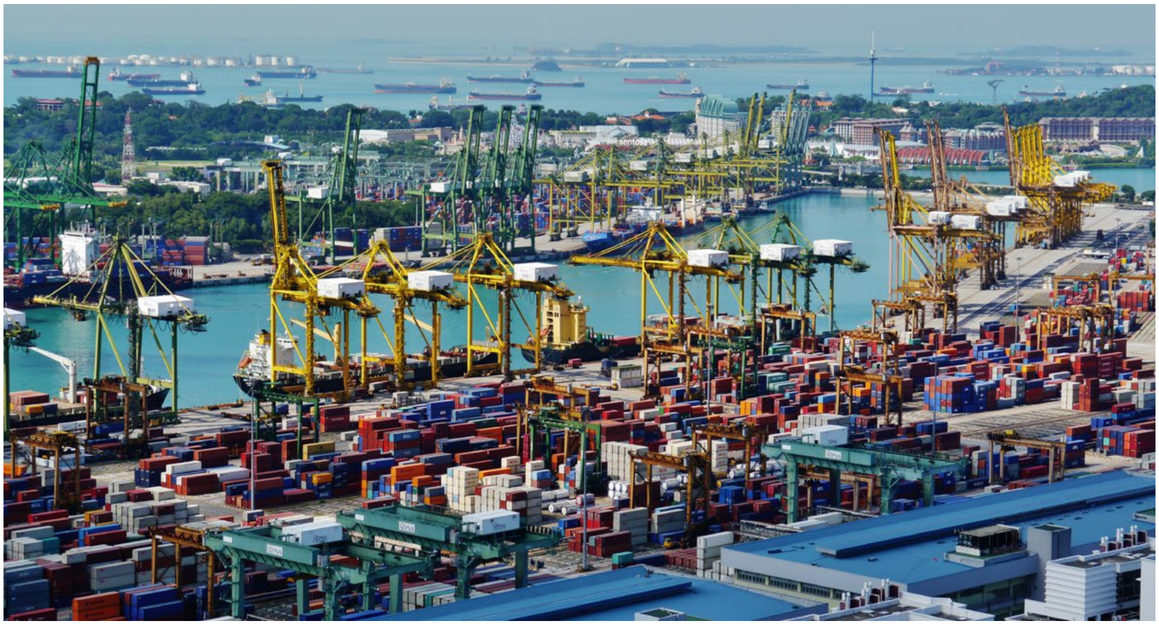
In 2017, Singapore topped the EAS region in the quality of port infrastructure, followed by Malaysia, Japan, and RO Korea – all with scores above 5 (**Table 6.2**).

Table 6.2: Quality of Port Infrastructure.

Country	2015	2016	2017
Cambodia	3.7	3.7	3.7
China	4.5	4.5	4.6
Indonesia	3.8	3.8	4.0
Japan	5.4	5.4	5.3
Malaysia	5.6	5.6	5.4
Philippines	3.2	3.2	2.9
RO Korea	5.2	5.2	5.2
Singapore	6.7	6.7	6.7
Thailand	4.5	4.5	4.3
Timor-Leste	2.2 (2014)		
Viet Nam	3.9	3.9	3.7

Source: World Bank, 2021.

[76] Data are from the World Economic Forum's Executive Opinion Survey, conducted for 30 years in collaboration with 150 partner institutes. The 2009 round included more than 13,000 respondents from 133 countries. Sampling follows a dual stratification based on company size and the sector of activity. Data are collected online or through in-person interviews. Responses are aggregated using sector-weighted averaging. The data for the latest year are combined with the data for the previous year to create a two-year moving average. (Source: World Bank Development Indicators)



Port of Singapore (Photo is licensed under CC BY-SA)

Efficient and well-connected container ports enabled by frequent and regular shipping services are key to minimizing trade costs, including transport costs, linking supply chains and supporting international trade.[77] Thus, port performance is a critical factor that can shape countries' trade competitiveness.

6.2.2 Port Container Traffic

Container shipping could lay claim to being the world's first truly global industry (ANSA McAL 2011). It is the industry, which makes it possible for a truly global economy to work. It connects countries, markets, businesses and people, allowing them to buy and sell goods on a scale not previously possible. The container shipping industry consists of shipping companies that transport containerized goods overseas through their regular liner services as their core activity.

EAS Region's role as host of the major ports for loading and unloading is reflected by the region's high contribution to containerized port throughput. Port container traffic is measured in twenty-foot equivalent units (TEUs). One TEU represents the volume of a standard 20-feet long intermodal container. The major ports in the EAS region handled 337.3 TEUs of containers in 2015, and the volume increased to 386.4 million TEUs in 2018, accounting for 48 percent of world container port traffic in 2018.[78] Meanwhile, developed economies accounted for 27 percent (in 2019).[79] The container port traffic of the countries in the EAS region is shown in **Table 6.3**.

[77] UNCTAD, 2019.
[78] UNCTAD, 2019.
[79] Data from UNCTADstat.

Table 6.3: Container Port Traffic (TEU).

Country	2015	2016	2017	2018	2019
Cambodia	392,000	400,000	644,500	742,100	
China	195,276,751	199,551,751	216,684,000	225,828,900	
Indonesia	12,031,700	12,431,700	12,829,600	14,060,600	14,763,630
Japan	20,577,013	20,784,617	22,054,800	22,433,824	
Malaysia	24,012,700	24,570,000	23,784,100	24,956,000	26,215,100
Philippines	7,210,441	7,621,441	8,090,420	8,637,520	
RO Korea	25,354,352	26,152,977	27,415,800	28,945,400	
Singapore	31,710,200	32,668,000	33,667,000	36,600,000	
Thailand	9,522,320	9,940,320	10,732,000	11,185,200	
Viet Nam	11,089,560	11,086,140	11,965,610	13,008,500	13,658,930

Source: World Bank, 2021.

Nine of the top ten container ports are in the EAS Region, with the Port of Rotterdam in The Netherlands as the tenth.[80] The top 20 container ports are shown in **Table 6.4**. As the largest exporter of goods moving on container services, Shanghai, China ranks as number one in the top fifty global container ports. Furthermore, Singapore still ranks as number two mainly because it is an important hub where containers from one-liner service are transferred to another liner service for on-carriage to their final destination.[81]

China

Seven ports of China are in the global top 10 container ports in 2020. These are the Ports of Shanghai, Ningbo-Zhoushan, Hong Kong, Shenzhen, Guangzhou, Qingdao, and Tianjin. The Port of Hong Kong was ranked first in 2004, but slipped to third in 2006-2012.

Singapore

The Port of Singapore is the world's second busiest port in terms of total shipping tonnage. It also trans-ships a fifth of the world's shipping containers, half of the world's annual supply of crude oil, and is the world's busiest transshipment port.[82] It was the busiest port in terms of total cargo tonnage handled until 2005, when it was surpassed by the Port of Shanghai. The Port of Singapore also has a terminal for cruise ships. The cruise lines that home port there include Princess Cruises, Royal Caribbean, and Holland America Line.

[80] World Shipping Council (Accessed in July 2021 from https://www.worldshipping.org/top-50-ports)
[81] World Shipping Council (Accessed in February 2021 from https://www.worldshipping.org/about-the-industry/global-trade/ports)
[82] https://www.singaporepsa.com/

Table 6.4: Top 20 Container Ports.

Rank	Port	Volume (million TEU)					
		2020	2019	2018	2017	2016	2012
1	Shanghai, China	43.50	43.30	42.01	40.23	37.13	32.529
2	Singapore	36.60	37.20	36.60	33.67	30.90	31.649
3	Ningbo-Zhoushan, China	28.72	27.49	26.35	24.61	21.60	16.670
4	Shenzhen, China	26.55	25.77	27.74	25.21	23.97	22.940
5	Guangzhou Harbor, China	23.19	23.23	21.87	20.37	18.85	14.744
6	Qingdao, China	22.00	21.01	18.26	18.30	18.01	14.503
7	Busan, South Korea	21.59	21.99	21.66	20.49	19.85	17.046
8	Hong Kong, S.A.R, China	20.07	18.30	19.60	20.76	19.81	23.117
9	Tianjin, China	18.35	17.30	16.00	15.07	14.49	12.300
10	Rotterdam, The Netherlands	14.35	14.82	14.51	13.73	12.38	11.866
11	Jebel Ali, Dubai, United Arab Emirates	13.50	14.11	14.95	15.37	15.73	13.270
12	Port Klang, Malaysia	13.24	13.58	12.32	13.73	13.20	10.000
13	Antwerp, Belgium	12.04	11.10	11.10	10.45	10.04	8.635
14	Xiamen, China	11.41	11.12	10.00	10.38	9.61	7.202
15	Tanjung Pelepas, Malaysia	9.85	9.10	8.96	8.38	8.28	7.700
16	Kaohsiung, Taiwan, China	9.62	10.42	10.45	10.27	10.46	9.781
17	Los Angeles, U.S.A	9.20	9.30	9.46	9.43	8.86	8.078
18	Hamburg, Germany	8.70	9.30	8.73	8.86	8.91	8.864
19	Laem Chabang, Thailand	7.55	8.10	8.07	7.78	7.22	5.830
20	Dalian, China	6.54	10.21	9.77	9.7	9.61	8.060

Source: World Shipping Council (https://www.worldshipping.org/top-50-ports)

RO Korea

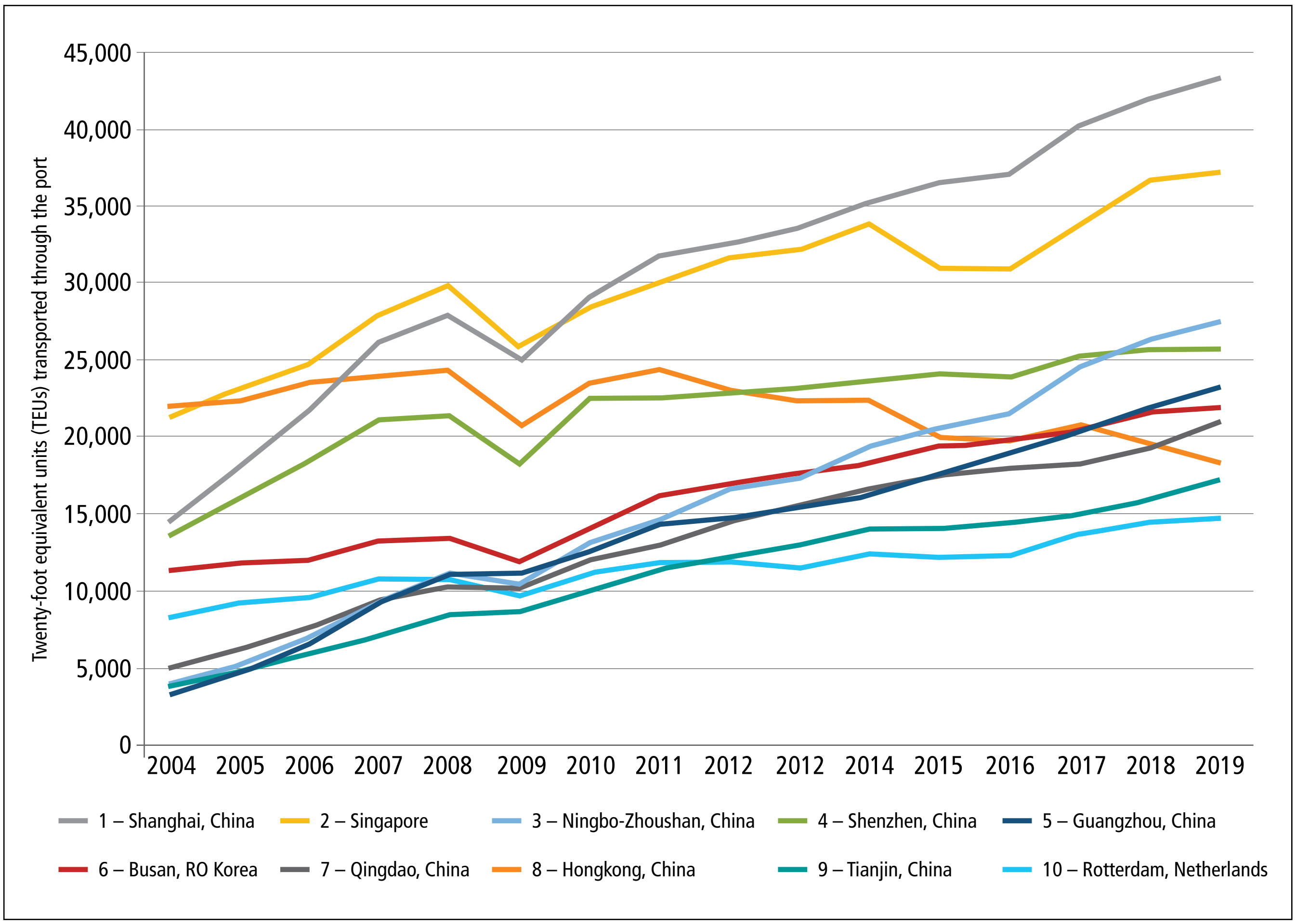
The Port of Busan is the 7th top container port in 2020. It consists of four ports and Gamman container terminal. The four ports are: (a) *North Port*, which provides passenger handling facilities and cargo; (b) *South Port*, which is home to the Busan Cooperative Fish Market – the largest fishing base in Korea; (c) *Gamcheon Port*, which was developed to supplement the North Port and handle increasing cargo volumes; and (d) *Dadaepo Port*, which deals mainly with coastal catches. The *Gamman container terminal* is operated by four ship carriers, namely Global Enterprises, Hanjin Shipping, Korea Express, and Hutchison Korea Terminal Ltd.[83]

[83] Ship Technology (https://www.ship-technology.com/projects/portofbusan/)

Malaysia

Port Klang was ranked 12th in the list of world's busiest container ports by throughput handled in 2020. The rank of Port of Tanjung Pelapas went up from 19th in 2019 to 15th in 2020. Bintulu Port is the world's largest export terminal for liquefied natural gas (LNG) while Johor Port is the world's largest palm oil export terminal.[84]

Figure 6.4: Port Container Traffic of Top 10 Container Ports, 2004-2019.



Source: World Shipping Council (https://www.worldshipping.org/top-50-ports)

[84] NSOC Report of Malaysia, 2018.

6.2.3 Shipping Connectivity

"Economic development in the EAS region has been accompanied by the strong growth of container port traffic and the setting of a major maritime trade corridor and its connectors. This corridor is structured along a North-South maritime axis that runs from a cluster of Japanese ports (Tokyo/Yokohama, Nagoya, Osaka/Kobe) to Singapore, including along the way major gateways, such as the port of Busan in South Korea, the Chinese ports of the Yangtze River and the Pearl River Delta, and the Port of Kaohsiung."[85]

Liner shipping is the service of transporting goods by means of high-capacity, ocean-going ships that transit regular routes on fixed schedules. The **liner shipping connectivity index** (LSCI) indicates a country's level of integration and position within global liner shipping networks. It is computed by the UNCTAD based on five components of the maritime transport sector: number of ships and ship calls, their container-carrying capacity, the size of the largest ship or maximum vessel size, number of services and companies that deploy container ships in a country's ports, and the number of other countries connected through direct liner shipping services (World Bank, 2021). The LSCI is an index set at 100 for the maximum value of country connectivity in 2006, which was China.

Low shipping connectivity makes weaker economies more vulnerable (UNCTAD). Low shipping connectivity leads to lower trade volume, but low trade volumes discourage shipping companies and ports from investing in better maritime transport connectivity. This vicious cycle has consequences on trade costs and competitiveness of countries in this situation (UNCTAD). However, technological advances (e.g., electronic documentation, digitalization, etc.) can be tapped to improve connectivity, efficiency, and productivity.

Table 6.5: Liner Shipping Connectivity Index (maximum value in 2006 = 100).

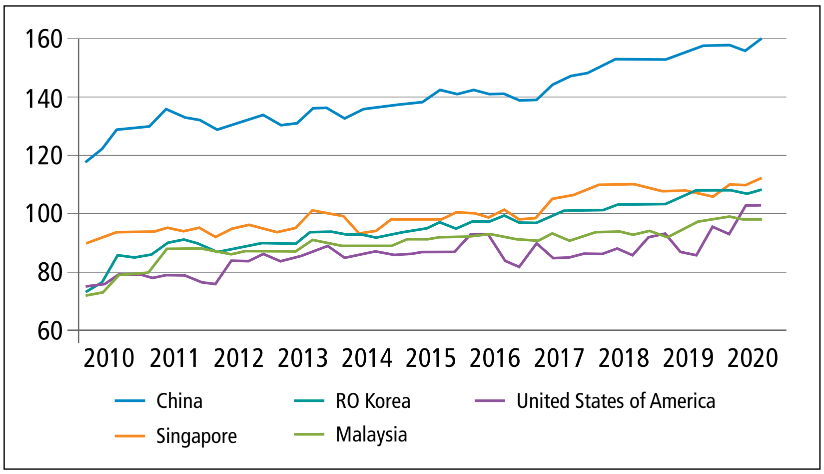
Country	2015	2016	2017	2018	2019
Cambodia	7.57	9.16	9.03	8.35	8.00
China	138.88	141.58	140.08	151.30	151.91
Indonesia	35.70	33.90	42.51	45.68	44.36
Japan	74.75	76.68	69.34	71.05	71.22
Malaysia	92.21	94.79	90.70	93.64	93.80
Philippines	22.38	28.00	28.11	29.32	30.63
RO Korea	98.32	99.81	98.53	102.29	105.11
Singapore	100.95	102.48	102.44	110.83	108.08
Thailand	42.55	44.64	42.37	45.06	52.92
Timor-Leste	5.78	2.86	2.91	2.91	2.91
Viet Nam	48.40	60.06	57.57	60.38	66.51

Source: World Bank, 2021.

[85] Port Economics, Management, and Policy 2020.

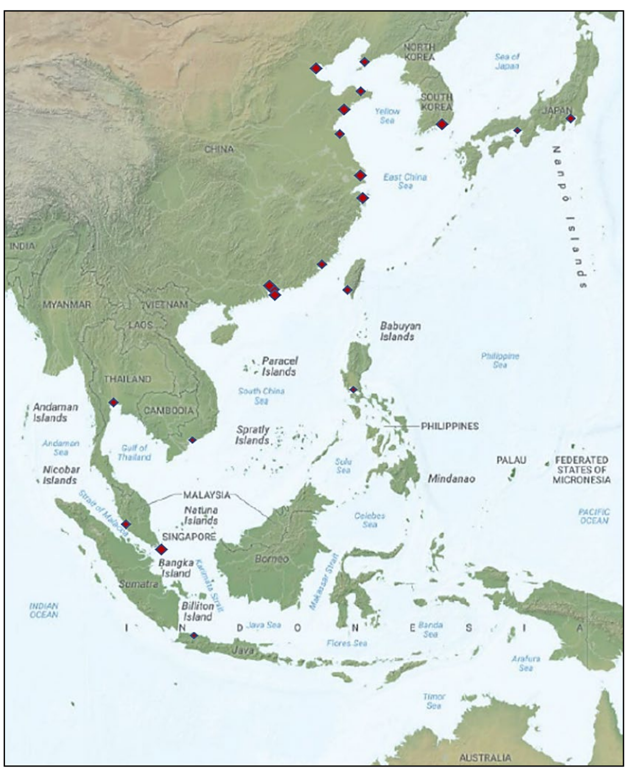
Over the last decade, the rank order among the most connected economies has not changed. Since 2011, the economies best connected to the global liner shipping network, as measured by the LSCI, were China, Singapore, and RO Korea, followed by Malaysia and the United States of America (USA). In 2020, USA showed a fast increase in its connectivity, allowing it to overtake Malaysia (**Figure 6.5**). Since 2006, the most connected country – China – has improved its index by 51 percent. Good port infrastructure and high shipping connectivity contribute to a country's competitiveness.

Figure 6.5: Liner Shipping Connectivity Index: Top Five Economies. (China Q1 2006 =100)



Source: UNCTAD, 2020.

Figure 6.6: Key Ports in EAS Region.



Source of base map: https://geopoliticalfutures.com/patrolling-seas-southeast-asia/

6.2.4 Logistics Performance

Logistics is the backbone of trade. It comprises a network of services that supports the physical movement of goods withing and across borders. Good logistics can result in reduced costs. Ports are important as they serve the supply chain management by providing multi-model transport system with variety of options, value added services, logistics center operations, and supply chain patterns and process. The current importance of ports goes beyond handling of ships and cargo.

The **logistics performance index** (LPI) is a benchmarking tool created by the World Bank to help countries identify the challenges and opportunities they face in their performance on trade logistics and what they can do to improve their performance.[86] Data are from LPI surveys conducted by the World Bank in partnership with academic and international institutions and private companies and individuals engaged in international logistics. The LPI is the weighted average of the country scores on six key dimensions:

1. Efficiency of the clearance process (i.e., speed, simplicity and predictability of formalities) by border control agencies, including customs
2. Quality of trade and transport-related infrastructure (e.g., ports, railroads, roads, information and communications technology)
3. Ease of arranging competitively priced shipments
4. Competence and quality of logistics services (e.g., transport operators, customs brokers)
5. Ability to track and trace consignments
6. Timeliness of shipments in reaching the destination within the scheduled or expected delivery time.

Among the EAS countries, Japan has the highest LPI score, followed by Singapore in 2018 (**Table 6.6**).

Table 6.6: Logistics Perfomance Index.

Country	2014	2016	2018
Cambodia	2.74	2.80	2.58
China	3.46	3.62	3.59
Indonesia	3.08	2.98	3.15
Japan	4.16	4.10	4.25
Malaysia	3.92	3.65	3.46

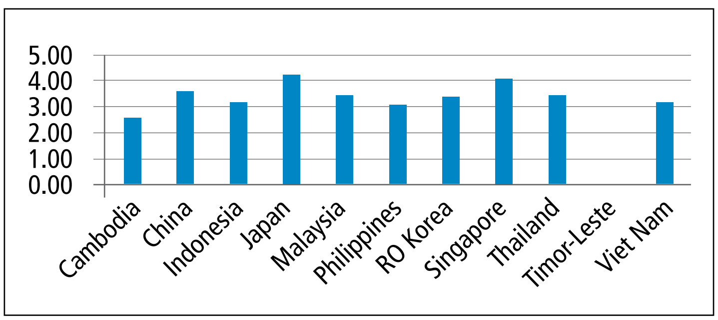
[86] Data are from Logistics Performance Index surveys conducted by the World Bank in partnership with academic and international institutions and private companies and individuals engaged in international logistics. 2009 round of surveys covered more than 5,000 country assessments by nearly 1,000 international freight forwarders. Respondents evaluate eight markets on six core dimensions on a scale from 1 (worst) to 5 (best). The markets are chosen based on the most important export and import markets of the respondent's country, random selection, and, for landlocked countries, neighboring countries that connect them with international markets. Details of the survey methodology are in Arvis and others' Connecting to Compete 2010: Trade Logistics in the Global Economy (2010). Respondents evaluated the quality of trade and transport related infrastructure (e.g., ports, railroads, roads, information technology), on a rating ranging from 1 (very low) to 5 (very high). Scores are averaged across all respondents.

Table 6.6: Logistics Perfomance Index. (cont.)

Country	2014	2016	2018
Philippines	3.00	2.86	3.06
RO Korea	3.47	3.45	3.40
Singapore	3.97	4.09	4.10
Thailand	3.30	3.37	3.46
Timor-Leste			
Viet Nam	3.22	3.12	3.16

Note:
Malaysia – Frequency with which shipments reach consignee within scheduled or expected time (1=low to 5=high)
Philippines – Ability to track and trace consignments (1=low to 5=high)
RO Korea – Efficiency of customs clearance process (1=low to 5=high)
Singapore – Competence and quality of logistics services (1=low to 5=high)
Thailand – Ease of arranging competitively priced shipments (1=low to 5=high)
Timor-Leste – Efficiency of customs clearance process (1=low to 5=high)
Viet Nam – Ease of arranging competitively priced shipments (1=low to 5=high)
Source: World Bank, 2021.

Figure 6.7: Logistics Performance Index (2018).



Source of data: World Bank, 2021.

Port of Yokohama, Japan. *(Photo: Wikimedia, CC BY SA 3.0)*

6.3 Contribution to the Economy and Jobs

Throughput is most used in the industry to measure port performance. However, this does not provide information on the regional and national economic benefits of the port. Therefore, port-related employment and value added are also used as port performance indicators.

Korea, RO[87]

- In 2015, GVA in ports was KRW 2.8 trillion, GVA in shipping was KRW 5.9 trillion, and GVA in vessel (ship building) and offshore plant construction and repair was KRW 7.8 trillion.
- In 2017, GVA in ports, shipping, and vessel (ship building) and offshore plant construction and repair were KRW 3.1, 3.5, and 8.9 trillion, respectively, for a total of KRW 15.5 trillion. Employment in ports, shipping, and shipbuilding was 110,000 in 2017.
- In 2017, ports, shipping, and shipbuilding accounted for 41.8 percent of the ocean economy, and 18.7 percent of employment in ocean economy.

Philippines[88]

- The GVA in ports and shipping was PhP 46.86 billion in 2015, and increased to PhP 57.37 billion in 2018. There were 821,000 people employed in this sector.

Thailand[89]

- Maritime transportation contributed around US$ 174.9 billion, or around 82 percent of the total contribution of ocean activities to the economy in Thailand. The value of imports and exports through shipping; shipyards and ship repairing; and maritime insurance were included in the estimation of maritime transport-related activities.

Malaysia[90]

- Around 95 percent of Malaysia's trade by volume is seaborne.
- In the 2011 Bank Negara Annual Report, the share of the transportation and storage sector was RM16 billion or 3.8 percent of Malaysia's GDP in 2011, while transport equipment, a component of 'Domestic Oriented Industries' contributed RM 29.7 million in 2010.
- In 2012, maritime transport attracted >RM 5 billion in investment. This is more than 40 percent of the total investments in transportation.
- Malaysian shipyards generated RM7.36 billion of revenues and provided 31,000 jobs in 2011.

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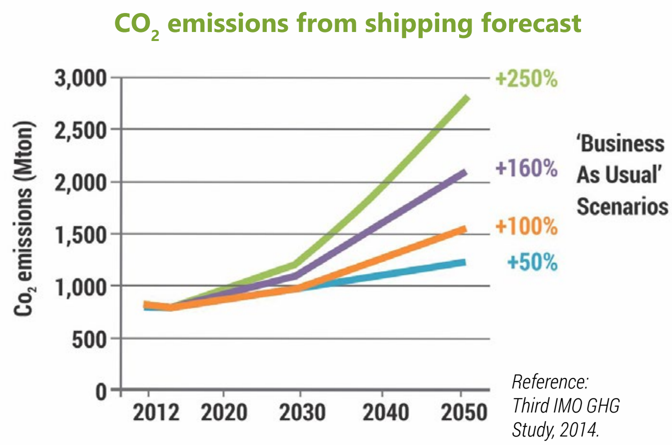
87 Chang, J., 2021. (USD 1 = KRW 1131.16 in 2015; USD 1 =KRW 1130.43 in 2017)
88 Bersales *et al*., 2019. (USD 1 = PHP 45.50 in 2015; USD 1 = PHP 52.66 in 2018)
89 PEMSEA and DMCR 2019. NSOC Report of Thailand.
90 PEMSEA and MIMA 2018. (USD 1 = RM 3.22 in 2010; USD 1= RM 3.06 in 2011; USD 1 = RM 3.09 in 2012)

6.4 Pressures

When holistic planning is absent, expanding port facilities can harm the environment and the people living in nearby cities and communities. For example, during construction, damage can occur through destruction of coastal habitats, land reclamation and the dredging, and the construction of buildings and roads to connect to the port.

Once operational, there are air and water pollutants, solid waste, noise pollution, and a higher-than-normal emission level of GHG. Ports do not exist in isolation and rely on many services for its good functioning. To address climate change effectively in ports, there is a need to understand the broader context within which ports operate. The resilience of ports is as good as its weakest link along the logistics value chain.

Figure 6.8: CO_2 Emissions from Shipping.



- Shipping CO_2 emissions are projected to increase by 50% to 250% in the period to 2050, despite fleet average efficiency improvements of about 40% and in the absence of further regulations
- Demand is the primary driver
- Technical and operational efficiency measures can provide significant improvements but will not be able to provide total net reductions if demand continues

Source: Smith, T. W. P. et al., 2014.

Ports should also have shore reception facilities to manage the wastes from ships.

The environment must be considered in all the details of shipping, from building of a new vessel, its operation, and to its decommissioning. Anchoring of ships can damage benthic communities. The IMO is helping to reduce the impact of the marine shipping industry by regulating exhaust emissions, anti-fouling, ballast water, and more.

Fine particulate matter ($PM_{2.5}$), sulphur oxides (SO_x), and nitrogen oxides (NO_x) that emerge from ship smokestacks lead to **premature mortality and morbidity** effects.[91] In particular, SO_x emissions form sulphate (SO_4) aerosols, which increase human health risks and contribute to acidification in terrestrial and aquatic environments.[92] Sulphates from ships also participate in regional short-lived aerosol cooling that affects radiative budgets.[93]

IMO and the shipping industry are taking action to clean up shipping emissions by reducing the sulphur content to 0.5 percent in ships' fuel oil. The IMO standards will reduce sulphate aerosols

[91] Corbett, J. J. *et al.*, 2007; Winebrake, J. J., Corbett, J. J., Green, E. H., Lauer, A. & Eyring, V., 2009.
[92] Hassellöv, I. M., Turner, D. R., Lauer, A. and Corbett, J. J., 2013.
[93] Sofiev *et al.*, 2018.

and provide health benefits to exposed populations. Ships' sulfur emission-related health impacts include: ~400,000 premature deaths from lung cancer and cardiovascular disease, and ~14 million childhood asthma cases annually (Corbett, et al., 2007).

Solution options include low sulfur fuel oil (LSFO), marine gas oil (MGO), liquid natural gas (LNG), and even burning the current fuel but having scrubbers on the exhaust stacks.

According to Sofiev, *et al*. (2018), cleaner marine fuels will:

- reduce ship-related premature mortality and morbidity by 34 percent and 54 percent, respectively, representing a ~2.6 percent global reduction in $PM_{2.5}$ cardiovascular and lung cancer deaths, and a ~3.6 percent global reduction in childhood asthma. Nevertheless, despite these reductions, low-sulfur marine fuels will still account for ~250,000 deaths and ~6.4M childhood asthma cases annually. Thus, more stringent standards may provide additional health benefits.
- reduce radiative cooling from ship aerosols by ~80 percent, equating to a ~3 percent increase in current estimates of total anthropogenic forcing. Therefore, stronger international shipping policies may need to achieve climate and health targets by jointly reducing GHG emissions and air pollution.

In addition, there are problems associated with the discharge of **ballast water**, which can pose serious ecological, economic and health problems. Ballast water, which helps keep vessels stable in the water and maintain ideal buoyancy, can **accidentally introduce aquatic invasive species**. **Figure 6.9** shows the location of MPAs, with some of them along the busy sea lanes. Biodiversity in marine ecosystems are at risk from invasive species introduced and spread through the release of ballast water of ships.

The economic and social impacts of invasive species include both their direct effects on native fisheries, agricultural productivity, public utility operations, property values, tourism, and outdoor recreation, as well as costs associated with invasive species control efforts. Using a comprehensive global database, and costs recorded from the existing literature, Cuthbert *et al*. (2021) examined the global cost of aquatic invasive alien species, and came up with the following findings:

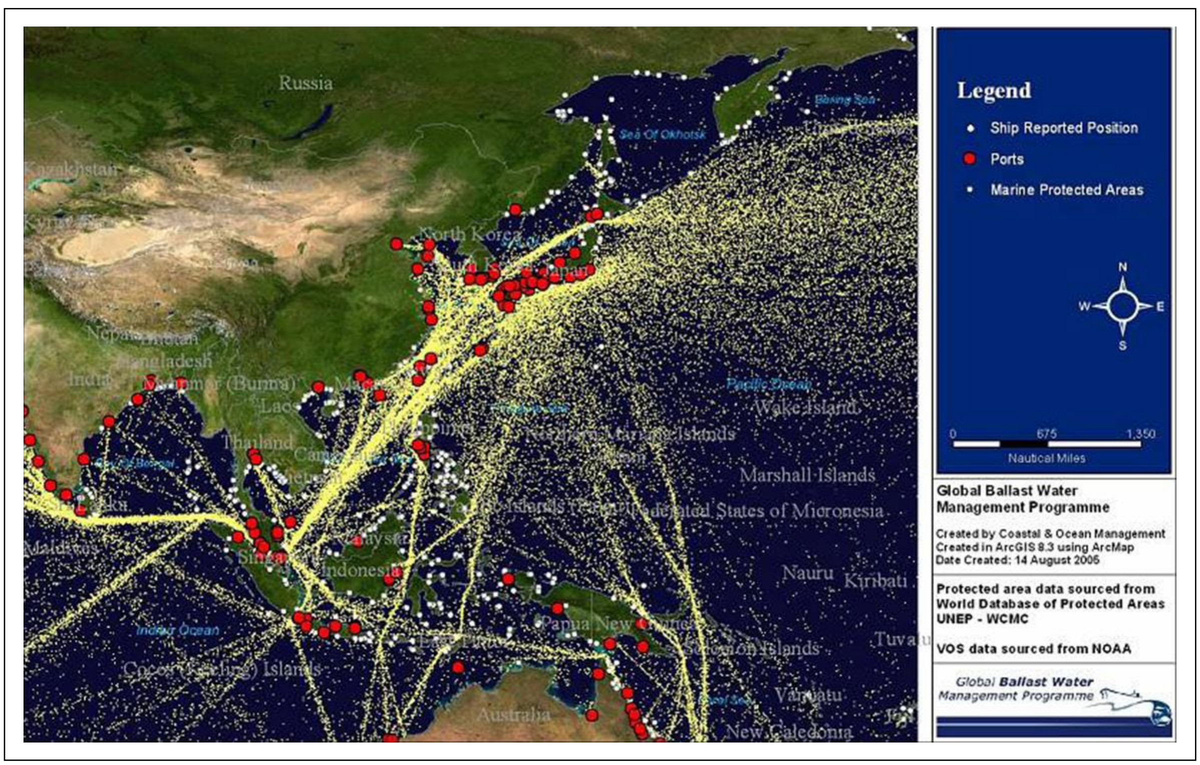
- Aquatic invasions have cost the global economy US$ 345 billion, and were principally a result of resource damages (74%); only six percent (6%) of recorded costs were from management of the invasive species.
- Largest costs were reported in North America (48%) and Asia (13%).
- Costs have increased exponentially over time, to at least US$ 23 billion in 2020.
- Most costs are caused by invertebrates (62%), followed by vertebrates (28%), then plants (6%).
- Aquatic invasion costs are underrepresented compared to terrestrial invasion costs.
- Taxonomic, geographic, and temporal gaps make these costs severely underestimated.

The condition of the hull (smooth hull) is essential in fuel efficiency. The speed of a ship decreases as its hull becomes infringed with marine growth. Anti-fouling paint (bottom paints) helps slow the growth of organisms that attach to the hull. Applying correct paint at the right hull area can reduce the frictional resistance of the ship, resulting in fuel savings.

Tributyltin or TBT is a biocide which came into being in the 1970s because of its brilliant anti-fouling properties as it prevents the growth of algae, barnacles and other marine organisms. However, TBT in anti-fouling paints was phased out of use from 1 January 2008 by IMO due to strong ecotoxicity, and the negative ecological effects observed worldwide, such as:

- TBT's harmful effects causes disruption of endocrine system of marine shellfish, which leads to imposex or the development of male sex characteristics in female shellfish.
- It also impairs the immune system of organisms and malformations of the shell of shellfish.

Figure 6.9: Ship Routes from Observed Ship Reporting Position and Location of Ports and Marine Protected Areas in the EAS Region.



Source: Global Ballast Water Management Programme.

Ports are expected to reduce their externalities and align their performance with sustainability considerations. Simultaneously, ports need to adapt to the impact of climate change and variability. However, corresponding measures and actions that support the shift to more sustainable and green ports will have cost implications and will require further investments, financing, capacity development, and knowledge transfer about new technologies.[94] Performance indicators and environmental reporting are becoming increasingly important due to the growing environmental concerns and stakeholder pressure.

Due to the fast pace of innovation in the shipping industry and the changes that are happening due to advanced technologies, artificial intelligence, internet, and automation, there will be **less jobs on board ships** and **more onshore jobs**. This would require the retraining and new skills. This is of particular importance to Asian countries that are suppliers of global maritime shipping labor, such as – by order of ranking – China, the Philippines, and Indonesia.[95] Such foreseen changes, however, offer opportunities to have more women in the maritime labor force.

6.5 Response Measures and Innovations for Blue Economy

The oceans provide the main transport arteries for global trade, which stimulate the global, regional, national, and local economies. With a timeframe to 2030, ports will have many ways in which they will be able to contribute to the sustainable development agenda. In particular, ports have these three-fold roles:[96]

1. Ports are inherently well positioned to contribute to societal development through job and wealth creation associated with facilitating trade and infrastructure investment.
2. As an integral part of many cities or towns and often located in ecologically valuable areas, ports have a responsibility to run their business with no harm to (and preferably enhancement of) the local community and the environment.
3. Increasing supply chain sustainability requirements driven by consumers, means ports will increasingly be expected to contribute to the sustainable development agenda.

6.5.1 Multilateral Agreements: Commitments to Keep the Ocean Clean, Safe, and Healthy

The International Maritime Organization (IMO) has taken the lead on issues, such as the regulations to protect the marine environment and pollution prevention, via the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (London Convention 1972); *Convention for the Prevention of Pollution from Ships or MARPOL, Annex VI; Convention on Oil Pollution Preparedness, Response and Co-operation* (OPRC Convention 1990); *Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances* (OPRC-HNS Protocol 2000); *Ballast Water Management (BWM) Convention 2004*; and

94 UNCTAD, 2019.
95 UNCTAD, 2020.
96 Green Port 2017 (https://www.greenport.com/news101/current-issue/apmt/are-sustainable-development-goals-relevant-for-sea-ports).

Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention). Countries that have ratified MARPOL, OPRC, OPRC-HNS, BWM and AFS Conventions are shown in **Table 16.2**.

MARPOL Annex VI sets regulations to limit the amount of ozone depleting substances, sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulate matter (PM) emitted from ships. It also has amendments with phased reductions; for example, since 2012 the global cap on sulfur content in ships' fuel oil has been at 3.5 percent, but it is set to decrease to 0.5 percent by 1 January 2020.

A 2013 amendment to MARPOL Annex VI mandates that all new ships are built according to the IMO's Energy Efficiency Design Index (EEDI), and that all ships follow the Ship Energy Efficiency Management Plan (SEEMP).

Enforcement, compliance with and monitoring of the new limit is the responsibility of States party to MARPOL 73/78, Annex VI. Ships found not in compliance, may be detained by port State control inspectors, and/or sanctions may be imposed for violations.[97]

Another regulation is the adoption of an additional amendment to MARPOL 73/78, entering into force on 1 March 2020, which will prohibit not just the use but also the carriage of non-compliant fuel oil for combustion purposes for propulsion or operation on board a ship – unless the ship is fitted with a scrubber. Regulations to reduce sulphur content in ship fuel are expected to bring positive results for human health and the environment.

With regard to the reduction of GHG emissions from international shipping, progress was made at IMO towards achieving the levels of ambition set out in the **Initial Strategy on reduction of GHG emissions from ships**, including on ship energy efficiency, alternative fuels, and the development of national action plans to address GHG emissions from international shipping.[98] IMO mandates **cut in shipping's GHG emissions by at least 30 percent by 2025 and 70 percent by 2050** compared with 2008 levels to bring the industry in line with the Paris Agreement (IMO, 2018).

Parties to the *OPRC Convention* are required to establish a national system for responding to incidents of oil and HNS pollution. The national system should include: (a) a national contingency plan, (b) designated national authorities, and (c) an identified national operation focal point (or focal points). Contracting parties are also mandated to enhance pollution preparedness and response capacity, either individually or through bilateral/multilateral cooperation, through: (a) setting up of pre-positioned equipment; (b) implementation of a program of exercises and training

97 UNCTAD, 2019.
98 UNCTAD, 2020.

of personnel; (c) development and implementation of plans and communication capabilities; and (d) establishment of a mechanism for coordinating the response. Rules and provisions for international assistance are also dealt with, emphasizing agreements among countries to provide international assistance to other State parties, and responsibility of requesting Parties to facilitate the receipt of such assistance in-country and to reimburse the costs incurred by the assisting Party.

The OPRC Convention provided the effective framework for the significant advances in oil spill preparedness and response around the world and remains to be an important instrument for strengthening government and industry partnerships. Underscoring the need for cooperation, the OPRC Convention and OPRC-HNS Protocol specifically call for State parties to endeavor to adopt bilateral or multilateral agreements for oil and chemical pollution preparedness and response. Major oil spill incidents provide evidence that response resources are more effectively used and deployed when these are operationally integrated.

The *Ballast Water Management Convention* covers over 73 percent of the world's merchant fleet tonnage and entered into force in September 2017. The Convention includes three sets of management measures: (a) Option 1 - mid-ocean ballast water exchange; (b) Option 2 - ballast water treatment using onboard treatment technologies; and (c) any alternative management options that will provide the same level of protection as given by Options 1 and 2. The goals of the convention are to minimise damage to the environment by:

- Minimizing the uptake of organisms during ballasting.
- Minimizing the uptake of sediments during ballasting.
- Ballast water exchange while at sea (the ship should be minimum 200 nautical miles from shore with a depth of minimum 200 m and can use the flow through or sequential method. At least 95 percent of the total ballast water should be exchanged).
- Treatment of the ballast water by chemical or mechanical influences (UV-radiation, filter, deoxygenation, ultrasound, etc.)

Control measures include:

- *International Ballast Water Management Certificate* attesting that the ship's ballast management plan meets the Convention's requirements
- Ballast water management plan
- Ballast water record book
- Ballast water management system

The *Convention on the Control of Harmful Anti-fouling Systems on Ships* was adopted in October 2001 to prohibit the use of harmful organotins in anti-fouling paints used on ships, and establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.[99] Under the terms of the AFS Convention, Parties to the Convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag, but which operate under their authority, and all ships that enter a port, shipyard or offshore terminal of a Party.

6.5.2 Sustainable and Green Ports

The Asia-Pacific Economic Cooperation (APEC) Port Services Network (APSN) has established a **Green Port Award System** (GPAS) with voluntary participation, ranking ports and encouraging them to improve their green performance through both self-evaluation and expert evaluation. As a green evaluation system for ports in the APEC region, it aims to improve environmental awareness, improve ports' capacity for sustainable development, advance green inter-operability, build a platform for sharing of best practices, and raise the profile of ports to promote overall competitiveness. By joining the GPAS program, a port signals that it highly values social responsibility, which in turn significantly raises the public image of the port.[100] As of 2018, the ports in Singapore, Malaysia (Port of Tanjung Pelepas and Westports, Port Klang), Indonesia (PT Terminal Teluk Lamong), Philippines (Port of Batangas and Port of Cagayan de Oro), and Thailand (Laem Chabanag Port) have received the Green Port Award. Examples of actions taken by some GPAS awardees are shown in **Box 6.1**.

The *Sustainable Port Development in the ASEAN Region*, a project of the German Technical Cooperation (GTZ) in collaboration with the ASEAN Ports Association (APA), aims to assist selected ports to comply with relevant international safety, health and environmental (SHE) codes, standards and conventions and improve their SHE management systems. The project covers the following components: capacity development through application of proven tools, systems and best available practices, development of modular training program on Port SHE management, adapting national legislation to international regulations, codes of practice and standards, and cooperation with other organizations and programs. Activities include development of model port SHE regulations, conduct of air emission inventory, conduct of study on access control/traffic management, and the implementation of the **Port Safety Health and Environmental Management System** (PSHEMS) in collaboration with PEMSEA The PSHEMS covers three standards: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environmental Management), and OHSAS 18001:2007 (Occupational Safety and Health). These three standards are now fused into the **Integrated Management System** (IMS).

Specific activities of ports towards environmental stewardship include environmental management for existing and new facilities, measuring and reporting on continuous improvement in environmental performance, addressing community concerns, such as human health, environment and quality of life, and responding to climate change.

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99 IMO, 2009.
100 Update Report on the APEC Port Services Network.

Indonesia. In 2015, the Indonesian state-owned terminal operator, PT Pelabuhan Indonesia III (Pelindo III), has launched its 'green' Lamong Bay Terminal, a milestone in the country's sustainable transport strategy.

China. In 2013, the Ministry of Transport released the **Green Port Rating Evaluation Standard**, providing the quantitative criteria in the four major aspects of port enterprises, i.e., energy saving and emission reduction, management concepts related to green development, actions and measures, and effects. As the largest cargo port in China, the Port of Shanghai implemented innovative measures and technologies, such as (a) "oil-to-electric power" renovation of some rubber-tired gantry (RTG) cranes; and (b) mobile shore-based variable-voltage/variable-frequency (VVVF) power supply systems. These measures have resulted in major benefits. Compared with the RTG of diesel power, the energy consumption decreased by more than 47 percent, and the costs of energy consumption were reduced by more than 72 percent. The port reduced CO_2 emissions by 910,000 tonnes, which is equivalent to 370,000 tonnes of coal.

Japan. The Port of Yokohama has joined the **Green Award Scheme** in 2017 in a bid to continually improve environmental protection and safety at the port. The Green Award is an international ship certification and incentive scheme. Certified ships are entitled to a 15-percent discount on port dues. Other Japanese ports like Kitakyushu Port and the Port of Nagoya are also providing incentives for Green Award Ships.

Malaysia. Malaysia is committed to reduce its carbon emissions level by 40 percent from 2005 GDP levels by 2020. Ports facilitate 95 percent of Malaysia's international trade and are expected to play a part to attain this target. As the nation's economy and trade grow, ports will be busier, and must therefore work at minimizing their emissions and pollution. The **Green Port Index** (GPI) has been established, and the ports in Malaysia have started to apply green practices, such as monitoring air and water pollution levels; introducing green building features; use of waste and heat recovery system in port buildings; disposing of waste from ships and ports in an environment-friendly manner; recycling; use of low-sulphur fuel; use of energy-saving bulbs; reducing idle time of trucks/equipment; rewarding port users that adopt environmentally-sound measures; protecting and restoring sensitive areas and habitats; etc.[101]

The Johor Port Authority has developed a *Green Port Policy*. The Port of Tanjung Pelapas, and Westports in Port Klang have won the **Green Port Award** of APSN.

Philippines. The Port of Batangas and Port of Cagayan de Oro have received the APSN Green Port Award, and recognized for its implementation of the PSHEMS. The two ports are now migrating to the IMS. The Philippine Ports Authority (PPA) also worked on the certification of the Ports of Zamboanga and Ozamiz for the IMS. The Ports of Iloilo and General Santos are also implementing PSHEMS. Shore reception facilities have been put in place in all base ports and private ports under

[101] PEMSEA, 2015; Kaur, 2015.

PPA. With operations in the port of Manila continuing to rise, the International Container Terminal Services, Inc's (ICTSI), the flagship Manila terminal, seeks to lower emissions by deploying new generation reach stackers.

Singapore. The **Maritime Singapore Green Initiative** aims to reduce the environmental impact of shipping and related activities and promote clean and green shipping in Singapore. In 2011, the Maritime and Port Authority of Singapore (MPA) pledged to invest up to S$100 million over five years for this Initiative. In 2016, following industry support, the Initiative was further enhanced and extended until 31 December 2019. It is a comprehensive initiative comprised of the following five voluntary programmes:

- Green Ship Programme
- Green Port Programme
- Green Technology Programme
- Green Awareness Programme
- Green Energy Programme

These programmes are designed to provide incentives to companies that adopt clean and green shipping practices over and above the minimum required by IMO Conventions. The initiative underscores Singapore's commitment as a responsible flag and port state to clean and green port and shipping.

Box 6.1. Actions Taken by the Recipients of the APEC Green Port Award

1. Philippines: Port of Cagayan de Oro

The Port of Cagayan de Oro is an international seaport in Macajalar Bay, at the northern coast of Mindanao. Due to the growth rate of the port and its expansion, the port authority and operators became concerned about the impact of their activities on the environment and consequently implemented a number of measures. This port has been recognized for its implementation of the **Port Safety, Health and Environmental Management System (PSHEMS).** The Port is also compliant with the **International Ship and Port Facility Security (ISPS) Code.** The port is motivated to comply with the *Philippine Clean Air Act*, and it adopted an air emission reduction program.

Among the innovations introduced in this port are: (a) Internet-Based Port Operations and Receipting for Terminals System (iPORTS) to improve terminal services; (b) shore-based power supply for ships using renewable energy; (c) solar power for lighting; and (d) shore reception facilities to handle solid and liquid wastes from ships.

Box 6.1. Actions Taken by the Recipients of the APEC Green Port Award (cont.)

Ships docked in ports use their auxiliary engines to produce electricity for hotelling, unloading and loading activities. Alternatively, a shore-to-ship power supply can be used to cover the electricity demand of ship at berth. The Port of Cagayan de Oro initiated the implementation of Shore-Based Power Supply (SBPS), using renewable energy. This is in consonance with the port's *Clean, Green and Blue Port Program*. It has resulted in savings from efficient energy and fuel use, and reduced GHG emissions.

Furthermore, in its effort to use renewable energy, and in congruence with the ISPS Code, the Port Management Office installed solar panel lightings to reduce dependence on traditional power supply sources. Even during power outages, the port sufficiently illuminates the berthing facilities and operational and perimeter areas to promote safety, security, efficiency, and productivity, especially during night-time operations.

In recognition of these actions, the Port of Cagayan de Oro received the ***Green Port Award*** from the APSN in 2018.

2. Malaysia: Port of Tanjung Pelapas and Westports in Port Klang

Two Malaysian Ports have won the ***Green Port Award*** of APSN: Port of Tanjung Pelapas, and Westports in Port Klang. These two ports are in the top 20 busiest container ports in the world. The following actions are being undertaken by these ports in line with their green ports initiative:

- Study of fuel quality of ships in ports
- Shore power to reduce emissions in Malaysian Ports
- Energy, electricity, and fuel saving: to reduce diesel consumption, and GHG emissions
- Tackling oil and chemical spills
- Ballast water management: Collaboration with University of Malaya to conduct baseline study of bacteria in water samples, and heavy metals, hydrocarbons and marine biological organisms in seawater and sediment samples from ballast water at designated ports.
- PSHEMS in Port of Tanjung Pelapas
- Other environmental initiatives: adopting marine sanctuary area; collaborating with Malaysian Nature Society; beach cleaning; mangrove planting; environmental monitoring, and waste management

Source: PEMSEA and DENR, 2019. PEMSEA and MIMA, 2019.

6.6 Investment Opportunities

6.6.1 Ports and Logistics Development

The world's seaborne trade exceeded 10 billion tonnes in a single year in 2015, with 60 percent passing through Asia.[102] Situated between the Indian and Pacific Oceans, Southeast Asia is well placed as trade expands. The demand for container in this region is expected to triple in the next 25 years, from about 100 million TEUs at present to around 350 million TEUs by 2040.[103]

The largest archipelagic countries, however, are not currently being optimized. Even when total trade in Southeast Asia rose by nearly 50 percent between 2004 and 2014, the combined container port throughput of Indonesia and the Philippines was a third less than the throughput in Malaysia, and less than half the level in Singapore.[104] Considering the potential huge market and increasing trade, these two countries and the ASEAN region as a whole are developing plans and investing to improve the maritime transport and related services (e.g., shipping, warehousing, shipbuilding and ship repairing, manufacturing of marine equipment and machinery, etc.). The maritime infrastructure development plans of ASEAN member States are presented in **Table 6.7**. In addition to improving port and logistics performance, the requirements for maritime safety, marine environment management, and more efficient, modern, and environmentally sound maritime services also represent investment opportunities.

Table 6.7: Maritime Infrastructure Improvement Plans.

Country	Highlights of Maritime Infrastructure Development Plans in 2015/2016 and Logistics Growth Projections
Brunei Darussalam	The Sultanate intends to establish an integrated logistics hub in Pulau Muara Besar (PMB). Once completed, the project is expected to increase the handling capacity of PMB to 1 million TEUs by 2021, from its current capacity of 330,000 TEUs per year.
Cambodia	Cambodia intends to increase the capacity of the Sihanoukville Autonomous Port to 1 million TEUs of container and 10 million tonnes of cargo per year. Other plans that the kingdom intends to pursue is to transform the Kampot Port as a new international port, and to expand the Phnom Penh Autonomous Port's handling capacity up to 500,000 containers per year.
Indonesia	As a major maritime country in the region, Indonesia plans to improve its maritime logistics infrastructure by setting up a sea toll road programme, which would include the improvement of 24 seaports (covering the five hub ports and 19 feeder ports). Supported by strong domestic consumption, manufacturing export increase, and the improvement of infrastructure in general, Indonesia's logistics sector was forecasted to increase by 15.5 percent by 2020.

[102] UNCTAD.
[103] Salim *et al*., 2017.
[104] Salim *et al*., 2017.

Table 6.7: Maritime Infrastructure Improvement Plans. (cont.)

Country	Highlights of Maritime Infrastructure Development Plans in 2015/2016 and Logistics Growth Projections
Lao PDR	Although Lao PDR is a landlocked country, it has been granted a 50-year concessions with an extendable option to develop and operate one of the Vietnamese ports, Vung And Port. Lao also plans to trasform its river port, which is loated at the Golden Triangle Special Economic Zone (GTSEZ), to become an international port.
Malaysia	Malaysia plans to improve its five existing ports and make one of them as a new regional hub. The development of such a regional hub aims to reduce the dominance of Singapore as the major hub in ASEAN. The logistics sector was expected to contribute up to 4.3 percent of Malaysia's GDP by 2020, a rise of 0.7 percent from 3.6 percent registered in 2015.
Philippines	The government of the Philippines has allocated 7 percent of thecountry's GDP for public infrastructure development for fiscal years 2017-2022. In 2017, the government allocated PhP 860 billion (US$ 16.8 billion) for infrastructure development, of which about PhP 355 billion is allocated for the improvement of roads, railways, seaports, and airports. The country's logistics sector was expected to grow by 15.6 percent annually from 2016 to 2020, and hit US$ 6.77 billion in terms of market size value by then.
Singapore	The Singaporean government is currently planning to reduce port operations in Pasir Panjang and Tanjong Pagar by setting up a mega project called Tuas Mega Port Development, which is expected to become the new sea transportation hub capacble of handling 65 million TEUs of cargo annually, or nearly double the present capacities of existing ports.
Thailand	The Thai government intends to strengthen its port facilities, particularly Laem Chabang Port. More specifically, it plans to initiate the third expansion phase of the port. This plan is well reflected in the Kingdom's Infrastructure Development Plan 2015-2022. The expansion is estimated to triple Laem Chabang Port's capacity to up to 18 million TEUs per year by 2021. Thailand's revenue from logistics sector was projected to hit US$ 96.5 billion by 2019.
Viet Nam	Through the country's development master plan, the Vietnamese government intends to achieve 2,100 million tonnes of cargo handling by 2020, a significant improvement of merely 1,274.5 tonnes in 2016. Viet Nam's logistics sector was expecteed to grow 12 percent per year, with total trade reaching US$ 632 billion by 2020.

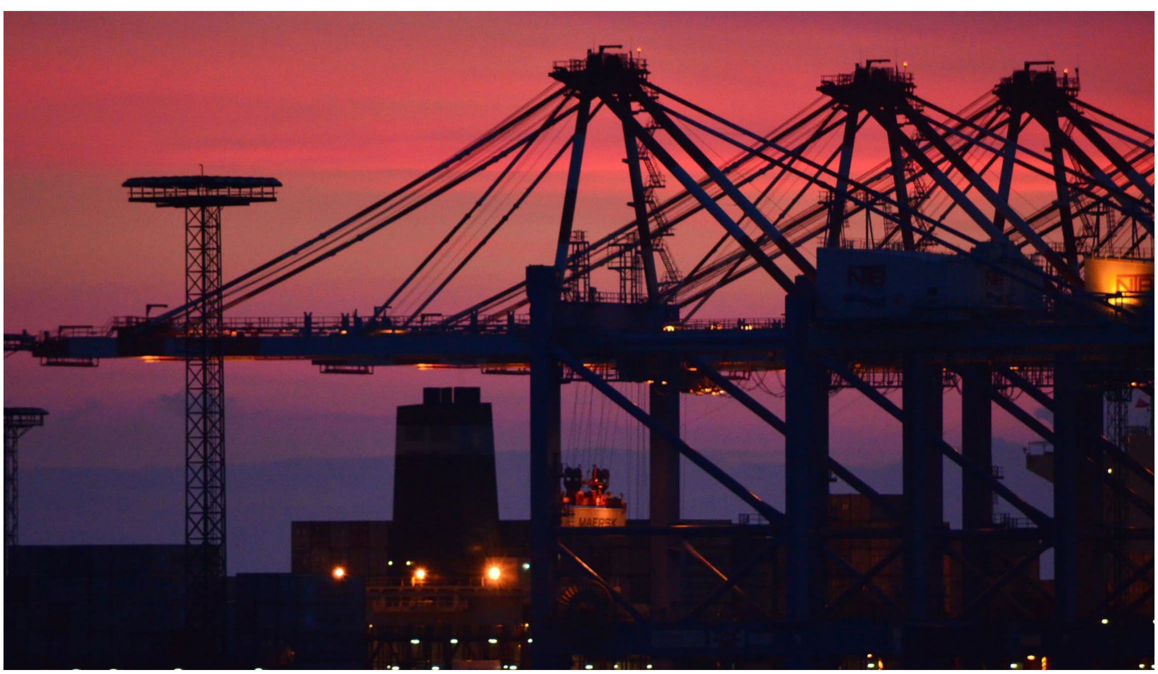
Source: Salim, Pranata and Tobing (2017), and Spire Research and Consulting (2016).

6.6.2 Green Shipping

Safety and emissions regulation and higher energy prices are leading factors changing the shipping industry. There are also many different and competing agendas at play. New technologies, new energy (e.g., LNG, methanol, biofuel, e-batteries, wind, solar panels), new engines, and new designs are becoming available. Automation and artificial intelligence are being developed for use in ships to improve efficiency. The difficulty for ship-owners, builders, equipment makers and financiers is not only what technology to support but *when* to invest. Decision-making will most likely be driven by a combination of price and performance. The award system and the monetary benefits that goes with it also provide incentives to transform to green ships. The **Green Award** surveys and certifies ships that demonstrate excellent performance. The certificate is recognised by the industry as a quality mark and rewarded with various benefits by ports and maritime products and services suppliers. Ships and ship managers must meet strict requirements covering safety, quality, and environmental performance to successfully pass the certification.

(See ***Section 7.3*** on *building of green ships*.)

Yangshan Port, China *(Photo: Wikimedia, CC BY SA 3.0)*



Laemchabang Port *(Photo from Thailand Environment Institute)*

Box 6.2. Green Shipping Solutions to be Compliant and More Efficient

"Green ship" is a name given to any seagoing vessel that contributes towards *improving the present environmental condition* in some way. Below are key options to consider to improve fuel efficiency, and reduce air pollution and other negative environmental impacts:

1) **Switch to low-sulphur fuel.** The move to lower sulfur content allows for the application of advanced emissions control technologies that substantially lower the harmful emissions from diesel combustion.
2) **Implement an exhaust scrubber system/sulphur scrubber system.** The system is geared towards reducing sulfur or capturing sulfur before it escapes through the exhaust funnels.
3) **Exhaust gas re-circulation system.** In internal combustion engines, Exhaust Gas Recirculation (EGR) is a NOx emissions reduction technique used in gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders.
4) **Use LNG fuel for propulsion.** Replacing heavy bunker fuel with LNG would reduce SOx and NOx emissions by 90 to 95 percent and curb carbon dioxide emissions by 20 to 25 percent.[105]
5) **Use wind energy with the sail and kite propulsion system.** The sail and kite system will use wind energy to move a ship through the water. This will help reduce fuel consumption and decrease NO_x, SO_x, and CO_2 emissions.
6) **Rotor sails to harness the wind.** The rotor sails could potentially *replace 20 percent of the ship's fossil fuels*, according to Norsepower Oy Ltd., which makes them. The spinning cylinders harness wind power to propel a ship. The rotor sails can be used with new vessels or retrofitted to existing ships. A.P. Moller-Maersk A/S is considering using this modern version of the old-fashioned sail to help power its ships.
7) **Battery boats.** Battery-powered ship engines and short-haul electric container vessel are being built and tested. For example, the *Yara Birkeland*, the world's first net-zero, battery-powered autonomous container ship, was delivered to Norwegian fertilizer company Yara Norge AS in November 2020, and being prepared for launching in 2021.[106] Such ships will contribute to the reduction of GHG emissions by ships.
8) **Slow your travel time.** Large ships burn 280-300 tonnes of high-sulfur fuel oil (HSFO) a day at high speeds, but only 80-90 tonnes a day at slower speeds.[107] Slower travel may cut costs and help reduce emissions.

[105] Wang, Siyuan and Notteboom, Theo. 2013.
[106] Lewis, M. 2021. https://electrek.co/2021/06/08/meet-the-worlds-first-electric-autonomous-container-ship/
[107] Viens, Ashely. 2019.

Box 6.2. Green Shipping Solutions to be Compliant and More Efficient (cont.)

9) **Use speed nozzles to save fuel**. Speed nozzles improve the propulsion efficiency of the ship by saving power. By using speed nozzles to power your ship, as opposed to traditional methods, results in *saving fuel by approximately 5 percent*.[108]
10) **Streaming bubbles**. Streaming bubbles out of tiny holes in a ship's underbelly can help to slice more cleanly through the water. According to Samsung, the technology can *cut fuel consumption by 4 or 5 percent*.[109]
11) **Have a proper waste heat recovery system**. Many ships have already been using a waste heat recovery system for a long time. However, recent advancements in technology, such as more efficient energy sources, will help reduce fuel consumption by converting the waste heat from the exhaust gases into steam. The steam can be used in other capacities, such as heating cargo area, accommodations, etc.
12) **Reduce fuel with more efficient steering gears**. There are two types of steering gears that are both eco-friendly and cost-effective: hydraulic and electro-hydraulic gears. By using one of these two efficient steering gears, ship's overall fuel consumption can be *reduced by approximately 4 percent on any given voyage*.[110]
13) **Apply the best, environment-friendly anti-fouling hull paint**. Anti-fouling paint (bottom paints) helps slow the growth of organisms that attach to the hull. Applying correct paint at the right hull area can reduce the frictional resistance of the ship resulting in *3-8 percent of fuel savings*.
14) **Submarine robot cleaners to improve fuel efficiency**. Organisms grow on the hull of ships. Robot cleaners are able to strip away debris and improve fuel efficiency. By removing barnacles that attach themselves to the ships' hull can decrease a vessel's fuel consumption by as much as 20 to 40 percent.
15) **Use Cargo Tank Coating with Improved Cleaning Capability**. The ability to move swiftly between various cargoes is also important. Selecting the right coating for cargo tanks extends the range of cargoes, reduces the time needed to switch them, and delivers the highest return on investment (ROI).
16) **Incorporate a ballast-free system.** New designs of ballast trunks, hull shapes, propulsion, trim and heel, Computational Fluid Dynamics tolls, and cargo segregation are being developed. Ships with ballast-free systems can terminate the entire requirements for expensive sterilization equipment like costly filters, ultraviolet irradiation, chemical biocides and other technologies, and generate saving of net capital cost of about $540,000 per ship.[111]

Sources: Yildirim, O. 2019; Campbell 2019; Park and Clenfield 2019.

[108] Campbell, U., 2019.
[109] Park, Kyunghee and Clenfield, Jason. 2019.
[110] Campbell, U., 2019.
[111] Dasgupta, Soumyajit. 2019.

Lessons Learned in Sustainable Ports and Shipping

Ports

Increase digitalization to improve port performance, monitoring and reporting, including on marine environment management. Develop and adopt a uniform set of blue economy criteria covering efficiency, air quality, water quality, marine habitats, wastewater, plastic waste and marine litter management, ballast water and invasive species management, building standards, and safety (accident prevention; emergency response for an oil and chemical spill). The criteria may be applied equally to all ports; however, allowance can be made for some degree of flexibility in how they would be achieved. Promote the participation of ports in the APSN Green Port Award System and World Ports Sustainability Program to improve efficiency and their green performance.

Ships

Implement a green ships certification program, such as the **Green Award** program or a program that incorporates World Ports Sustainability Program's (WPSP) **Environmental Ship Index** (ESI). To have a broader impact, the ports could incentivize eco-innovations in the shipping sector, with a future eye towards vessels that perform better in reducing air emissions than required by the emission standards of the IMO and prohibiting certain vessels that do not meet a certain minimum threshold standard.

Incorporate domestic ocean-based transport in new or updated Nationally Determined Contributions (NDCs) to contribute to achieving the commitments under the Paris Agreement. Options[112] include:

- Defining a specific GHG target for domestic shipping and domestic fleets.
- Defining a non-GHG target to phase out GHG emissions from coastal passenger transport by 2030 through technology transfer and research and development in battery- and wind-powered ferries.
- Committing to developing cross-sectoral decarbonization plans that link strategies to transition land-based energy sources and supply chains with ports and marine fleets.
- Committing to financing technology transfer and research and development for the transition to zero-emission passenger and freight transport.

[112] World Resources Institute (https://www.wri.org/blog/2021/01/4-ocean-based-solutions-advance-climate-action-through-ndcs)

Linking Ports and Shipping

Consider a harmonized set of blue economy standards across all East Asian ports and shipping companies. There could be material repercussions or rewards for meeting the standards. Countries may want to consider using both regulatory and incentive-based policies to set a floor and to drive innovation, respectively.

Capacity building and political will are key. Once there is a blue economy plan for ports and shipping, a willingness and ability among members is required to enact these changes. In-person and virtual training programs to improve regional expertise and buy-in by leaders at the national level are essential. This ensures that port staff and the environment and transportation sectors are enabled to meet the relevant objectives and targets in the shipping and ports sector to bolster the blue economy.

Ships in Surabaya, Indonesia. *(Photo by D.M. Bautista)*

7 Shipbuilding and Repair

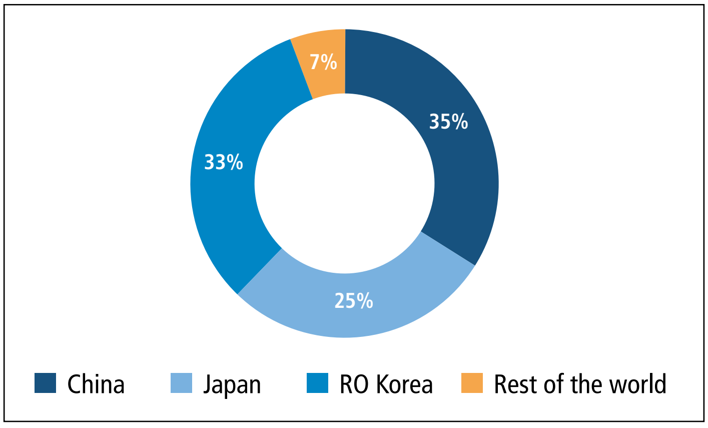
"Light boats sail swift, though greater hulks draw deep."
William Shakespeare

7.1 Shipbuilding Output and Contribution to Economy

The shipbuilding and ship repair (SBSR) sector is a capital- and labor-intensive industry and plays a vital role in the socioeconomic development of the country. The sector is composed of all enterprises engaged in the design, construction, overhaul, alteration, and repair of watercrafts. These enterprises operate a facility called shipyard/drydock where ships are being built or repaired.

Countries in the EAS region have modern shipbuilding industry with China, RO Korea,and Japan accounting for 93 percent of the global merchant shipbuilding.

Figure 7.1: Share of Global Merchant Shipbuilding (2019).



Source: Center for Strategic and International Studies, 2021.

China[113]

The shipbuilding industry has continued to improve efficiency, and the cycles of the three major types of shipbuilding cycles have been greatly shortened, approaching the world's advanced level. The average fuel consumption and the energy efficiency design index (EEDI) of ships newly built by shipbuilding enterprises have dropped by more than 20 percent compared with those in 2008,

113 Information is from PEMSEA 2018. NSOC of China (unpublished).

meeting the standards of the IMO. Shipbuilding capacity has been enhanced comprehensively in China. The country took the lead in all the three major shipbuilding indicators (ships built, handling order, contracting (new order) from 2010 to 2013.

There are over 1,200 shipyards that produce a wide range of vessel sizes and types. The China Shipbuilding Industry Corporation (CSIC) and China State Shipbuilding Corporation (CSSC) are the two largest shipbuilding conglomerates in China, and they were merged in 2019. CSSC is the world's top manufacturer of commercial vessels in 2020 based on new orders.

Japan[114]

Japan has 1000-plus shipyards, of which 855 construct ships up to 500 GT, while 264 shipyards are capable of constructing ships over 500 GT. Some of these yards are privately owned (i.e., unlisted) individual enterprises, while others form part of larger private or public (listed) companies that operate multiple yards. The three biggest enterprises in Japanese shipbuilding, measured by current orderbooks (in compensated gross tonnage or CGT), are Imabari Shipbuilding, Tsuneishi Holdings, and the Oshima Shipbuilding Company. These three companies, as well as Universal Shipbuilding, Mitsubishi Heavy Industries, and Namura Zosensho, are in the top 30 shipyard groups worldwide.

The Japanese government noted that small shipyards tend to construct coastal ships, such as general cargo ships, oil products tankers, chemical tankers, coastal ferries and fishing vessels. Large shipyards construct large ocean-going ships, such as bulk carriers, crude oil tankers, container ships, large passenger ships, and roll-on-roll-off (Ro-Ro) ships.

The contribution of Japan's shipbuilders to the country's GDP has fluctuated over time and shipbuilding now represents a fairly low percentage of total Japanese value added. By 2008, the activity of building and repairing ships and boats accounted for 0.18 percent of Japanese value added. In line with the data on output, employment in the shipbuilding sector is currently a relatively small part of Japan's total employment. Data provided by the Japanese government suggest that as of April 2012, around 0.13 percent of Japan's workforce (or 84000 people) was engaged in the shipbuilding industry (including subcontractors, but not those in the marine equipment industry).

However, the role of shipbuilding in the Japanese economy is larger when the activities of other shipbuilding-related industries are considered. Japan's shipbuilders exist within a wider maritime cluster that provides crucial upstream and downstream products and services. The marine equipment manufacturing sector is an important part of the maritime cluster, together with the research, development, and design sector. Upstream from shipbuilding, steel and marine

[114] The information on shipbuilding in Japan is from OECD 2016. Peer Review of the Japanese Shipbuilding Industry.

equipment are important input sectors. Japan is the world's second largest producer of steel after China. The downstream activity of ship classification is also important, as an internationally traded service employing expert technical staff. Japan's ship classification society, *ClassNK*, had 7847 ships under class as of May 2012, representing approximately 20 percent of the world merchant fleet.[115] This organization employs 967 technical staff in its offices in Japan and abroad. ClassNK also certifies shipyard and manufacturer quality assurance systems, offers consultancy and support services, and provides training programs for ship surveyors.

RO Korea[116]

Producing 33 percent of the world's new ships every year, RO Korea is one of the world's largest shipbuilders.

In 2012, it constructed ships capable of loading 31.4 million GT, accounting for 33 percent of the global total. There has been a total of nine medium/large size shipyards operating since 2000s in Korea. However, the small size shipyards have been continuously decreasing since 2007, which reached its peak with 66 shipyards.

The total ship orders reached its peak of 49.9 million tonnes in 2007, thereafter showed decreasing trend due to the oversupply of the world shipyards and the 2009 global financial crisis and economic recession. The shares of domestic and export ship orders were 7.3 percent and 92.7 percent in 2015, respectively. In 2015, the export of the shipbuilding and offshore plants amounted to US$ 40.11 billion, the third biggest export product following semiconductors (US$ 62.92 billion), and automobiles (US$ 45.79 billion).

Shipyard. *(Photo from BOI)*

[115] www.classnk.or.jp/hp/en/about/aboutNK/index.html (cited in OECD 2016).
[116] Information on shipbuilding in RO Koreas is from: Ministry of Oceans and Fisheries and PEMSEA, 2019.

Although the ship orders have decreased since 2007, the workers employed in the shipyard (both in shipbuilding and offshore plant) have continuously increased from 143,581 in 2007, to 153,769 in 2010, and to 203,282 in 2015. In addition to the shipbuilding industry, the shipbuilding equipment companies also employ a large number of people.

In 2016, there is a total of shipbuilding and offshore plant-related 14 colleges, 19 universities, and 17 graduate schools in Korea. The R&D cost of the shipbuilding industry is about one percent (1%) of sales. The sales and research and development expenses for 2015 were KRW 26,603.6 billion and KRW 282.5 billion, respectively.

Philippines[117]

In terms of capacity, the Maritime Industry Authority or MARINA regulations categorized shipyards in the Philippines as large, medium and small. *Large* shipyards have lifting capacities of 20,000 and above Deadweight Tonnage (DWT) ships for building or repair; *medium* shipyards for capacity of 3,000 to 19,000 DWT; and small shipyards for 2,999 DWT and below. There were 118 shipyards in 2015, of which 7 were large, 14 were medium, and 97 were small. The shipyards utilize various major equipment/facilities and employ more than 45,000 employees nationwide, excluding subcontractors. These shipyards have constructed 118 ships corresponding to about 1.8 million Gross Tonnage (GT) in 2015.

The arrival of foreign shipbuilders in the Philippines propelled the export growth of Philippine-made ships in the international market. After being recognized as the 4th largest shipbuilder in the world in terms of Vessel Completion in Gross Tonnage in 2015 by the Shipbuilders Association of Japan, shipyards established in the Philippines are now building more ships of larger tonnage capacities like bulk carriers, container ships and passenger ferries (BOI, 2017).

Besides shipbuilding and ship repair, the development of ship breaking, or ship recycling yards/ facilities is also considered an investment opportunity in the country. Considering the older age of the existing ships and entry of newer modern ships, ship recycling and/or ship breaking of uneconomical ships is inevitable. Furthermore, the government, through the collaboration of the different concerned agencies, is working for the development of **Marine Industrial Hubs**. These industrial hubs to be strategically located in the Luzon, Visayas, and Mindanao are being designed to enhance the operations of shipbuilding and ship repair in the country.

Singapore[118]

The shipbuilding sector's manufacturing output in 2016 was S$13.1 billion. The shipbuilding sector had a total value added of S$3.8 billion in 2016, about 0.9 percent of Singapore's GDP.

117 Information on shipbuilding in the Philippines is from: PEMSEA and DENR, 2019.
118 Information on shipbuilding in Singapore is from: National Parks Board (Singapore) and PEMSEA. 2019.

Jurong Shipyard (now one of several facilities owned by Sembcorp) launched the national industry in 1963 as a joint venture between the Economic Development Board (EDB) and Ishikawajima-Harima Heavy Industries (IHI). It was Singapore's first commercial shipyard offering ship repair services.

Sembawang Shipyard is the second of Sembcorp Marine's yards, and it commenced operations from the conversion of the unused naval base, the Royal Navy Dockyard in late 1968. Located at Tuas View Extension, the Sembcorp Marine Tuas Boulevard Yard, will be an integrated, mega-shipyard that will eventually cover 206ha and service the global O&G and marine sectors. The 73.3-ha Phase I of the yard began in 2013 with four very large crude carrier (VLCC) drydocks with a total dry dock capacity of 1.55 million DWT. Phase II's marine operations began in the first quarter of 2017.

In 2002 the offshore and marine business of Keppel was privatised, resulting in the integration of Keppel Shipyard with Keppel FELS and Keppel Singmarine to form the current Keppel Offshore & Marine group. Keppel Shipyard was founded by Temasek Holdings in 1968, when Keppel Harbour was reclaimed from the British Royal Navy after their withdrawal from Singapore. It is currently a leader in the conversion of Floating Production Storage and Offloading (FPSOs), Floating Storage and Offloading, and Floating Storage and Re-gasification Units.

Thailand[119]

There were 227 factories in 2017 (Thai Shipbuilding and Repairing Association, 2017), but 189 enterprises are registered as legal entities under the Department of Business Development. However, only 91 enterprises are registered in the online accounting system of the Department of Business Development in 2016. The total revenue of these 91 enterprises were US$ 0.36 billion in 2016.

Viet Nam[120]

There are about 97 shipyards (from 1,000 DWT and above) belonging to SBIC, Vinalines, PVN, some military and private enterprises in Viet Nam. There are 92 factories in the North, 13 factories in the Central Region, and 15 factories in the South. The total designed capacity of newly built factories is 2.6 million DWT/year, equivalent to 150-200 pieces/year.

[119] Information on shipbuilding in Thailand is from: PEMSEA and DMCR, 2019.
[120] Information on shipbuilding in Viet Nam is from: PEMSEA, VASI and MONRE, 2021.

7.2 Pressures and Issues

Shipbuilding industry can cause coastal water pollution due to oil and sedimentation caused by heavy metal deposition, which directly affects marine aquatic flora and fauna, as well as hinders the development of other sectors, such as salt-making, aquaculture and coastal tourism. The main pollutants are heavy metals in the form of oxide powder: Pb_3O_4, Pb_2O_3, $PbCrO_3$, CuO, ZnO, Fe_2O_3, TiO^2, $ZnCrO_3$; cellulose paints ($-C_3H_7O_2$ $(OH-)_2$), epoxy paints (-CHOCH-), phenol formaldehyde paints ($-C_6H_5O-$) and oil alkyd paints (-CHO-).[121]

The use of paints with tributyltin (TBT) is banned under the *International Convention on the Control of Harmful Anti-fouling Systems in Ships* (AFS Convention). TBT is an aggressive biocide that has been used in anti-fouling ship paints since the 1970s. The toxicity of TBT prevents the growth of algae, barnacles and other marine organisms on the ship's hull. However, TBT leaches from the paint and enters the marine environment, causing harm to nontarget marine organisms.

7.3 Response: The Next Gen Green Ships for Blue Economy

The maritime transportation is under pressure to shift to eco-friendly fuel-powered ships as the IMO mandates cut in PM, SO_x, and GHG emissions. Thus, the maritime industry — shipping, ports, and shipbuilding sectors — has to include air pollution and climate considerations as priority areas in its development and modernization plans. It is likewise important to upgrade the existing shipyard facilities in order to meet safety, environmental protection, and quality standards that are globally accepted.

Options for the shipping industry include retrofitting existing ships to use fuels with a lower emissions profile, apply digitalization and more automation, and adopt new ways of transporting cargo altogether, such as reintroducing wind-powered propulsion.[122] A green ship would leave the least amount of PM, carbon, and sulphur emissions.

China[123]

To address the increasing demand for energy saving and environmental protection in the shipping and shipbuilding industries, China Classification Society actively promotes green ships and provide solutions for management and technology of energy saving and emission reduction for new and existing ships. In 2013, China Classification Society launched the best trim solution for ships, developed the "Ship Trim Optimization System". By reasonably changing the operation habits of the ship, it effectively reduces the power demand of the main engine, saves fuel consumption, and reduces carbon emissions. After adopting this system, a whole ship can save up to 5-8 percent

121 PEMSEA and VASI. 2021. NSOC Report of Viet Nam.
122 Zeldovich, 2020.
123 The green shipping initiatives of China are from PEMSEA. 2018. NSOC Report of China (unpublished).

of actual energy use. The annual costs of fuel saved by a single ship are about RMB 3,200,000 (~US$ 516,500), bringing about obvious economic and social benefits. The system has been adopted by the CSCL, Taiwan Wan Hai Lines, Hebei Ocean, Ningbo Ocean, and many other shipping enterprises. China Classification Society has also launched the "China Classification Society Online Intelligent Management System of Ship Energy Efficiency", which enables real-time monitoring of energy consumption, navigation equipment parameters, energy management, energy efficiency management and other functions; allows real-time remote monitoring of ship equipment, navigation dynamics, ship energy consumption, and energy efficiency, and guides carriers and ship operators to formulate comprehensive energy management plans.

China has actively carried out research and development (R&D) of green ships and related technologies, and has built and put into use dual-fuel powered vehicles. China also entered a new stage of green development in shipbuilding industry. China vigorously promotes R&D of green marine engines, and development of the LNG-powered ships. LNG as the ship fuel almost produces no particulate matter, and can result in emission reduction of 90-95 percent sulphur oxides, about 80 percent of nitrogen oxides, and 20-25 percent of carbon dioxide, compared with heavy fuel oil, while improving the combustion efficiency by about 30 percent (Wang and Notteboom 2013). Since 2010, China has conducted successful trial navigation of inland ships powered by both LNG and diesel. In October 2013, "Haiyang Shiyou 521" - the first LNG dual-fuel port tugboat indigenously developed by China National Offshore Oil Corporation (CNOOC) - was delivered in the Gaolan Port, Zhuhai, Guangdong.

Japan

The founding aim of the *Planning and Design Center for Greener Ships* is to contribute to the growth of Japan's shipbuilding industry by developing advanced environmental performance-enhancing technologies that will respond to tightening of environmental regulations over the long term through consolidation of the country's technologies in ship design, and by advancing commercialization of next-generation greener ships.[124]

Nine domestic shipbuilders will pursue the development of advanced environmental performance-enhancing technologies for the era of carbon neutrality, targeting near-zero carbon emissions, and engage in activities focusing on research and development related to commercialization of green ships. In addition, the center will seek the participation of domestic companies involved in marine business, shipping, trading houses, and other entities supporting the center's aims.

With an eye on Japan's goal of net-zero greenhouse gas emissions by 2050, Tokyo-based Anchor Ship Partners will launch the roughly 600-billion-yen (US$ 5.65 billion) LNG bunkering ship, Kaguya in 2021 to aid decarbonization efforts in the shipping sector.[125]

[124] Maritime Logistics Professional Network, 2020.
[125] Daichi Mishima, 2021.

Japan is also developing automated ships to improve efficiency and safety. Nippon Foundation is backing the country's development of ocean-traversing autonomous ships, and aims to see crewless ships make up 50 percent of Japan's local fleet by 2040. With the foundation's support, a plan is in place to have a container ship pilot itself from Tokyo Bay to Ise, a coastal city in central Mie Prefecture, in February 2022. The 380-km (236 mile) voyage will be the world's first test of an autonomous ship in an area with heavy marine traffic.[126]

RO Korea[127]

RO Korea's Ministry of Ocean and Fisheries (MOF) has legislated the *Act on the Development and Promotion of Eco-friendly Vessels*. Part of MOF's workplan in 2021 is green shipping. In accordance with the so-called '2030 Green Ship-K Strategy' formulated in December 2020, MOF plans to build or convert 528 ships (388 in the public sector and 140 in the private sector) into low-carbon ships, such as LNG or hybrid powered by 2030, and will make efforts to develop zero-carbon ships, such as hydrogen or ammonia powered ships.[128]

Dual fuel engine is behind the demand for South Korean ships. The bulk of global orders obtained by Korean shipbuilders in 2020-2021 has been in multi-fuel capable of running on either bunker C oil, LNG, or liquefied petroleum gas (LPG).

Korean shipyards also offer ammonia-ready designs to add to their competitive edge. Ammonia-ready ships are dual fuel vessels that are designed to be easily converted to run on ammonia once relevant technologies are fully developed. Ammonia is a promising zero-carbon fuel that can help meet the IMO's GHG reduction target for 2050. The industry forecasts that ammonia dual-fuel engine ships will be rolled out as early as in late 2024.

The MOF plans to invest nearly US$ 33 million (KRW36.4 billion) in the next five years to build a testbed for accelerating the development of green vessels. A new vessel will be built for the purpose of validating different engines, including those powered by electricity or hydrogen. Through the development of eco-friendly ships, the government intends to encourage the transition to green shipping. In 2019, the government had announced its plans to convert around 140 state-owned ships to operate on environmentally friendly fuels by 2030. RO Korea is working to achieve carbon neutrality by 2050, and this initiative is expected to help in achieving the target.

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[126] Davis, River and Tsuyoshi Inajima. 2021.
[127] From: Hellenic Shipping News (1 June 2021); Ship Technology (29 April 2021)
[128] https://www.mof.go.kr/en/page.do?menuIdx=1503

Singapore

In 2017, Singapore's Jurong Port has signed a Memorandum of Understanding (MoU) with Nanyang Technological University (NTU) to jointly research and develop smart multi-energy systems, and testbed alternative energy solutions to be conducted as part of Jurong Port's Living Lab programme.[129] The MoU with NTU also includes environmental monitoring. Other components of Jurong Port's Living Lab programme include collaboration with industry partners to develop and test various environmentally sustainable solutions, and in areas, such as multipurpose port productivity, Internet of Things (IoT), data and visual analytics and safety and security. Together with the Maritime and Port Authority of Singapore (MPA) and other stakeholders, Jurong Port's Living Lab programme aims to play an important role to encourage greater innovation in the maritime and port industry. The MPA and Shell corporation are also partnering to advance clean fuel technologies for the shipping sector.

Photo by Maritime and Port Authority of Singapore

[129] Green Port. 2017. https://www.greenport.com/news101/asia/jurong-pursues-alternative-energy-research

8 Offshore Oil and Gas: Boon And Bane

"We cannot solve our problems with the same thinking we used when we created them."
- **Albert Einstein**

Offshore oil and gas are resources from the ocean area. The offshore oil and gas industry has emerged as a major industry, with the discoveries of reserves in the marine areas. Several countries in the EAS region are located on the Sunda Shelf, known to be a site with huge hydrocarbon deposits. Indonesia, Malaysia, Thailand, Brunei, Viet Nam, Cambodia, and Timor-Leste benefit from the rich energy resources available in this continental shelf.

The oil and gas industry provides opportunities to other support service providers as well. It created a huge demand for equipment, such as oil rigs, tankers, and offshore service vessels. The demand for supporting services by the oil and gas industry creates employment and facilitates technology transfer and development of technical skills.[130]

The oil and gas sector is necessary to supply the energy needed for the maritime sectors in the current absence of supply from renewable energy sources. The people and the whole economy, including the spectrum of fisheries, maritime tourism, marine transportation, and maritime industry, require energy resources. Energy or fuel is a primary need for the operation of passenger, container, and cargo ships as well as fishing vessels. The fuel cost of sea transportation is more than 60 percent of operational cost. For fishing boats, fuel represents more than 40 percent of the cost of fishing operations in Indonesia (Wahyudin, 2012).

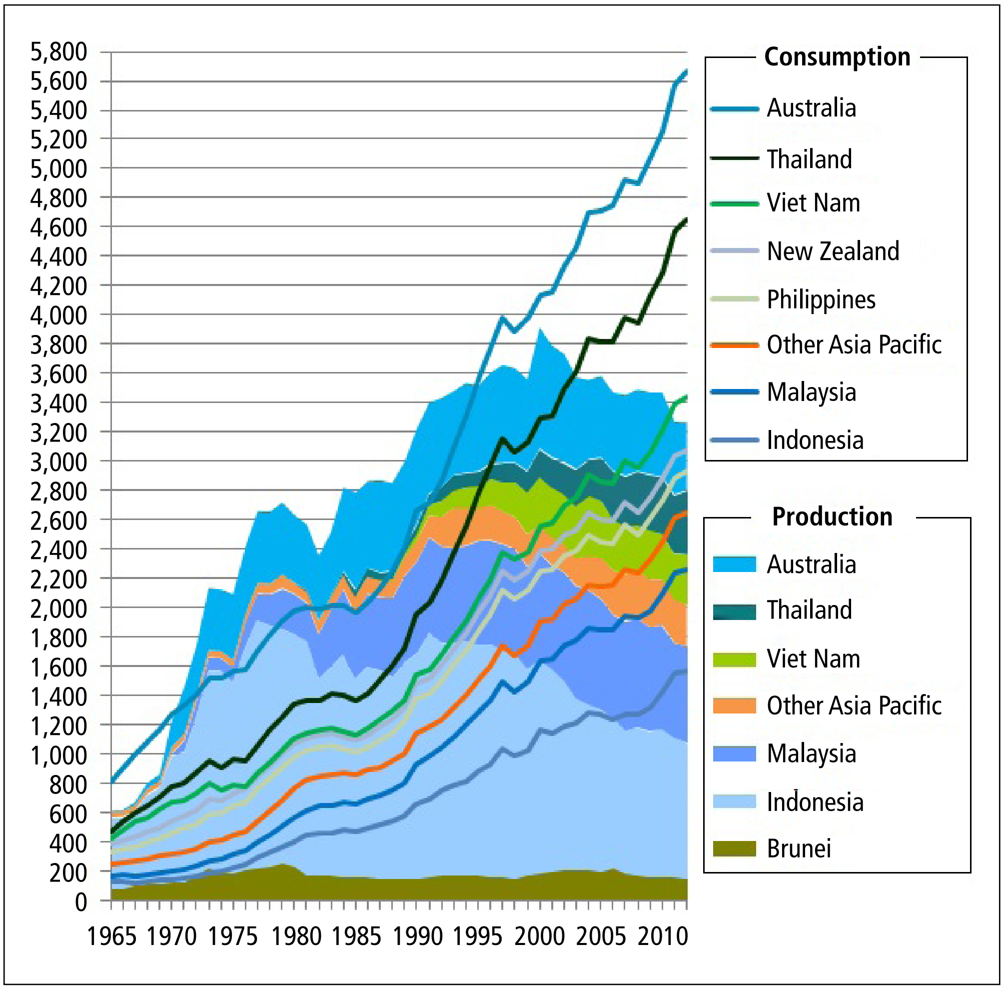
Nevertheless, oil and gas are depletable resources, and their use as fossil fuel has resulted in the GHG emissions, with consequent effects on the climate, weather patterns, and ecosystems. Most of the emissions of human-caused (anthropogenic) GHG come primarily from burning fossil fuels—coal, natural gas, and oil—for energy use. In the long term, and in view of transforming to blue economy development and overall sustainable, resilient, and inclusive economic growth, there is a need to shift towards alternative, renewable energy supply that could be a complement or even a replacement for fossil-based fuels. The ocean also offers potential for marine renewable energy (e.g., offshore wind power, tidal, wave and current energy, etc.)—a way out of the traditional energy conundrum. This is a time when we should be turning towards renewable energy alternatives, energy efficiencies, and conservation, and not phasing out fossil fuels.

[130] Ebarvia, 2016.

8.1 Proven and Potential Reserves and Country Production

The countries in the region are both producers and consumers of oil and gas (**Figure 8.1**). The region has proven oil reserves of around 1.2 km^3 (7.7 billion barrels), with an estimate of 4.5 km^3 (28 billion barrels) in total. Natural gas reserves are estimated to total around 7,500 km^3. A 2013 report by the U.S. Energy Information Administration raised the total estimated oil reserves to 11 billion barrels.[131] A total of 54 crude and natural gas projects are expected to start operations in six countries in Southeast Asia during 2019–2025, according to GlobalData's latest report.[132] Since the introduction of offshore exploration and production in the 1960's, Southeast Asia has gone through a remarkable transition from an onshore to an offshore focused region with more than 80 percent of oil production coming from offshore fields in 2011. Also the region has recently moved into deepwater exploration and production activities which now make up more than 10 percent of the offshore production.

Figure 8.1: Oil Production And Consumption.



Source: BP Statistical Review, 2013.

131 U.S. report details rich resources in South China Sea." (https://web.archive.org/web/20130213111846/http:/focustaiwan.tw/ShowNews/WebNews_Detail.aspx?ID=201302090013&Type=aIPL)

132 https://www.offshore-technology.com/comment/southeast-asia-oil-and-gas-2025/

Indonesia

Indonesia has been active in the oil and gas sector for more than 130 years, after the first oil discovery in North Sumatra in 1885. A member of OPEC since 1961, Indonesia suspended its membership in 2009 after years of declining production. According to the BP Statistical Review of World Energy 2019, Indonesia holds proven oil reserves of 3.15 billion barrels and potential oil reserves of 4.36 billion barrels at the end of 2018 (**Table 8.1**). On the other hand, Indonesia has proven natural gas reserves of 96.06 trillion cubic feet (TCF) and potential natural gas reserves of 39.49 TCF.

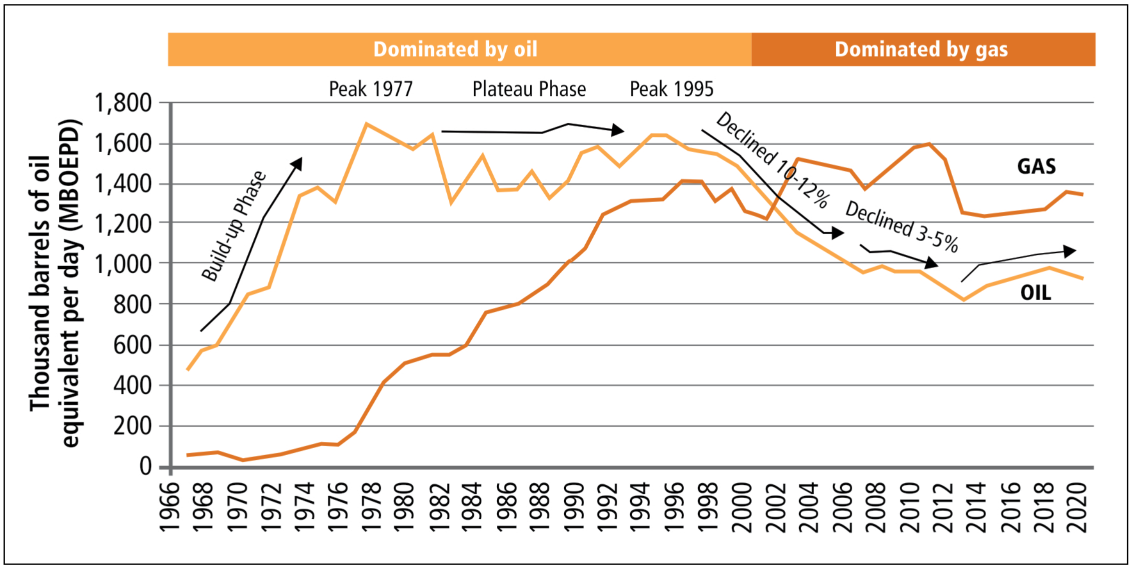
Indonesia's oil and gas production has been dominated by gas production (60%) since 2002 (**Figure 7.2**). The condition is expected to continue in the next few years. After reaching a peak in 1995, oil production declined by 10-12 percent per annum in the next ten years, and further declined by 27.6 percent between 2010 and 2015. As of 2015, Indonesia's oil and gas production was 786 MBOPD for crude oil, and 8,102 MMSCFD for natural gas. In 2018, crude oil production decreased to 772 MBOPD, and natural gas production likewise decreased to 7,760 MMSCFD (**Table 8.1**).

Table 8.1: Indonesia's Oil and Gas Reserves and Production.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Reserves												
Oil (Million Barrels)	8,400	8,220	8,000	7,760	7,730	7,401	7,550	7,370	7,305	7,251	7,535	7,512
Proven	3,990	3,750	4,300	4,230	4,040	3,740	3,690	3,620	3,603	3,307	3,171	3,154
Potential	4,410	4,470	3,700	3,530	3,690	3,670	3,860	3,750	3,702	3,944	4,364	4,358
Gas (TCF)	165.00	170.10	159.63	157.14	152.89	150.70	150.39	149.30	151.33	144.80	143.70	135.55
Proven	106.00	112.50	107.34	108.40	104.71	103.35	101.54	100.26	97.99	102.00	101.40	96.06
Potential	59.00	57.60	52.29	48.74	48.18	47.35	48.85	49.04	53.34	42.80	42.30	39.49
Production												
Crude oil (MBOPD)	972	1,006	994	1,003	952	918	825	789	786	831	804	772
Natural gas (MMSCFD)	7,283	7,460	7,962	8,857	8,415	7,110	6,826	8,218	8,102	7,939	7,621	7,760
New contracts signed*	28	34	34	21	31	39	14	7	12	2	0	11

Source:
Reserves of oil and gas are obtained from DGOG, MoEMR
2007-2012 Crude Oil and Natural Gas Production: BP Statistical Review of World Energy
2013-2015 Crude Oil and Natural Gas Production: SKK Migas Annual Report 2013-2015
2016 Crude Oil and Natural Gas Production: Press release of MoEMR on CNN Indonesia
2017-2018 Crude Oil and Natural Gas Production: SKK Migas Annual Report 2017-2018
New contracts signed: MoEMR, SKK Migas Annual Report

Figure 8.2: Indonesia's Oil And Gas Production.



Source: SKK Migaas Annual Report, 2018.

Indonesia spent decades relying on the oil and gas sector's contribution to economic growth. However, in recent years, the oil and gas sector's contribution to state revenues has decreased significantly along with the decline in reserves and production. The significant decrease in Indonesian Crude Price (ICP) from US$ 95.57/barrel in 2014 to US$ 48.26/barrel in 2015 (decrease by almost 50% from 2014) has a direct impact on the decline in the state revenues. The state revenue from the oil and gas industry decreased by almost 80% from IDR 216 trillion in 2014 (14% of state revenues) to IDR 44 trillion in 2016 (2.8% of state revenues), before rising oil prices improved the contribution of the oil and gas sector in 2017 and 2018. The Ministry of Finance (MoF) declared the receipt of non-tax oil and gas state income of IDR 143 trillion in 2018.

Meanwhile, the oil and gas component of export revenues decreased alongside the oil price, reaching its lowest level in 2016 when the oil price fell below US$ 30/barrel. Bank Indonesia notes that oil and gas exports contributed about 8 percent of total exports in 2016-2018, down from a high 17 percent share in 2011. The Indonesian oil and gas imports have exceeded exports since 2012, and this energy trade deficit may exceed the trade surplus generated by other sectors.

Philippines

Aggregate domestic oil production, including condensate, declined by 11.5 percent, from 702.4 thousand tonnes of oil equivalent (kTOE) in 2016 to 621.8 kTOE in 2017, while its contribution total indigenous energy supply stood at 2.1 percent share. The reduction is attributable to the lower production output reported in Matinloc, Galoc, and Malampaya fields during this period. Likewise, natural gas production was lower by 1.4 percent in 2017 compared with its 2016 level of 3.3 MTOE. Natural gas production stood at 3.2 million tonnes of oil equivalent (MTOE), equivalent to an 11 percent share to overall indigenous supply in 2017. The decline in outputs is due to the following factors:

- Malampaya's 20 days maintenance shutdown in first quarter of 2017
- Effect of Magnitude 5.6 and 6.0 earthquakes in Mabini, Batangas on 8 April 2017, which led to the outages of Avion, Santa Rita, San Lorenzo, San Gabriel and Ilijan Natural Gas Power Plants. The country sources 100 percent of its natural gas requirements from the Malampaya gas field in Palawan.

As of June 2018, the country produced 54,680,776 BBLs of oil from Nido, Matinloc, North Matinloc and Galoc, and 1,938,305.87 million standard cubic feet per day (MMSCF) of natural gas from Malampaya (**Table 8.2**). Based on the Upstream Oil and Gas Roadmap, the DoE expects to be able to discover and explore additional oil fields and be able to produce more oil and gas in the long term.

Table 8.2: Oil And Gas Production In Northwest Palawan (2018).

	Field	Total Production (BBL Oil or Condensate/ MMSCF Gas)
Oil	Nido	19,276,841.00
	Matinloc	12,584,966.00
	North Matinloc	2,276,413.00
	Galoc	20,542,556.12
Gas	Malampaya	1,938,305.87
Condensate	Malampaya	75,041,800.82

Source: Department of Energy (http://www.doe.gov.ph/pep/upstream-oil-and-gas-roadmap-2017-2040).

Investment in downstream industries. The "Philippine Downstream Natural Gas Regulation" (PDNGR) circular sets forth the rules and regulations governing the downstream natural gas industry in the country. This includes infrastructure siting, design, construction, expansion, modification, operation, and maintenance. PDNGR also intends to transform the country as a regional LNG trading and transshipment hub. The Philippine National Oil Company (PNOC) is developing and will operate the Batangas LNG Hub Project, the Batangas Energy Supply Base, and enhance the PNOC Petrochemical Park in Bataan. The PNOC Batangas LNG Hub Project aims to establish a complete value chain LNG facility and ensure the supply of gas to the existing and future gas-fired power plants upon the termination of the Malampaya Service Contract in 2024 and beyond. The project components shall cover sourcing of the LNG supply, establishing LNG storage units, regasification, distribution facilities and a power plant. The power plant shall serve as the project's social component, envisioned to produce cheaper electricity to supply Philippine Economic Zone Authority's identified industries and small power utilities groups (SPUG) areas.

Thailand

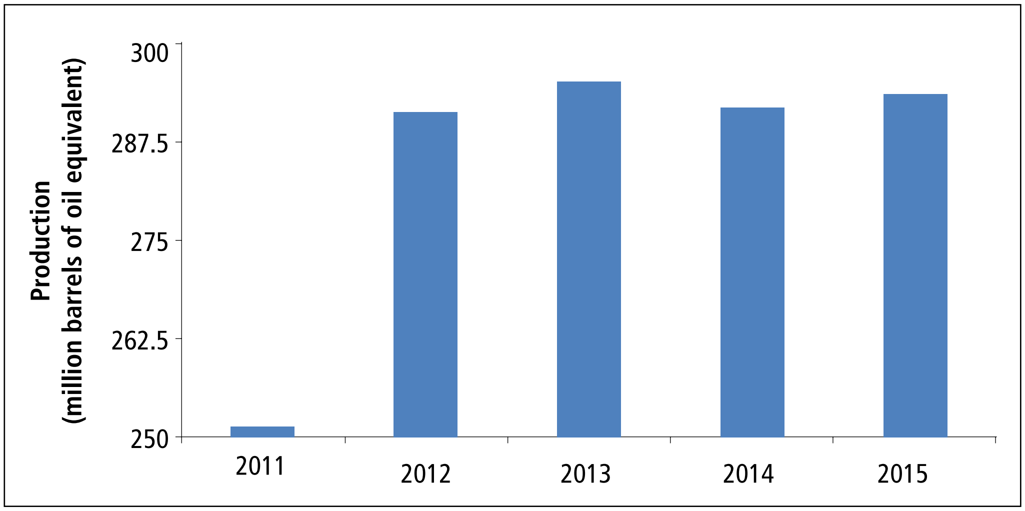
The national production in 2015 was equivalent to 320.3 million barrels of crude oil, a 0.5 percent rise from 2014, but with a 20 percent drop in revenue because of oil price drop. All petroleum concessions in maritime sources of Thailand were in the Gulf of Thailand (GoT), with most of them in the EEZ (**Figure 8.3**). As of December 2015, there were 438 installations. Most of them were wellhead platform. Total indigenous petroleum production from 2011-2015 was shown in **Figure 8.4**. It hit the lowest in 2011 and began to increase and level off from 2012-2015.

The government revenues from concessionaires' petroleum businesses are royalty, special remuneration benefits, petroleum income tax, and revenues from the Malaysia-Thailand Joint Development Area (MTJDA). During 2011-2013, the state revenue rose steadily. However, the revenue started to decrease in 2013 and continued to go downhill (**Figure 8.5**).

Figure 8.3: Thailand Petroleum Concession Map (2015).

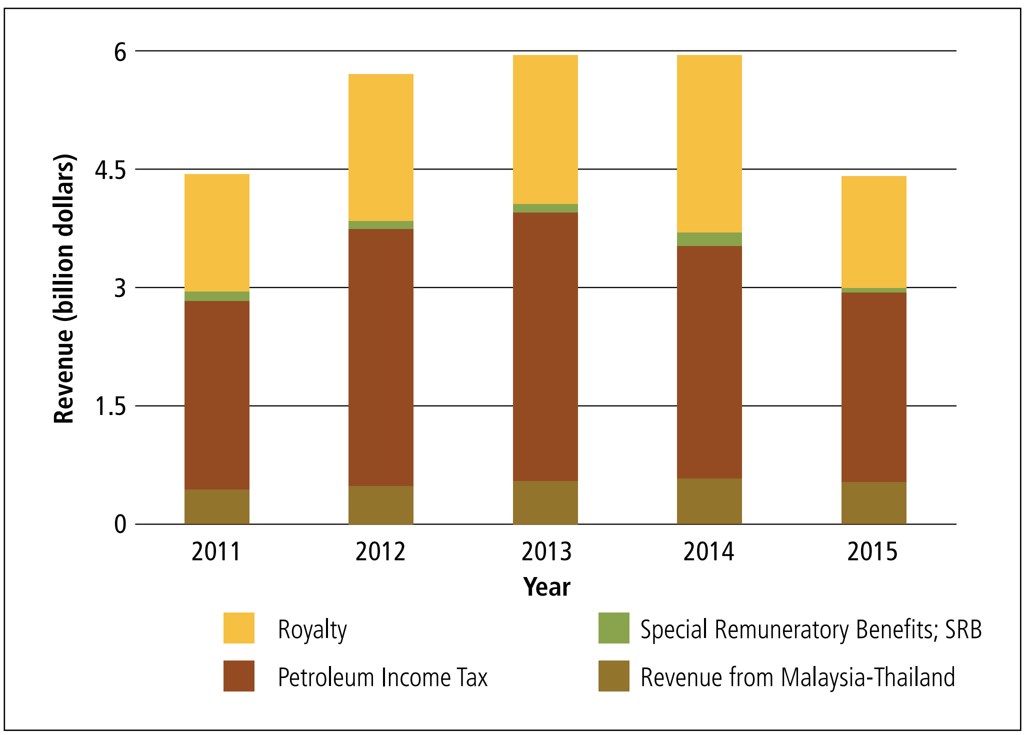
Source: Department of Mineral Fuel, 2015.

Figure 8.4: Total Indigenous Petroleum Production.



Source: Department of Mineral Fuels, 2015.

Figure 8.5: State Revenue from Petroleum Industry in Thailand.



Sources: Department of Mineral Fuel, 2011-2015.

Timor-Leste

Since the restoration of independence, three offshore fields have been developed, namely: Elang Kakatua, Bayu Undan, and Kitan in the Joint Petroleum Development Area (JPDA).

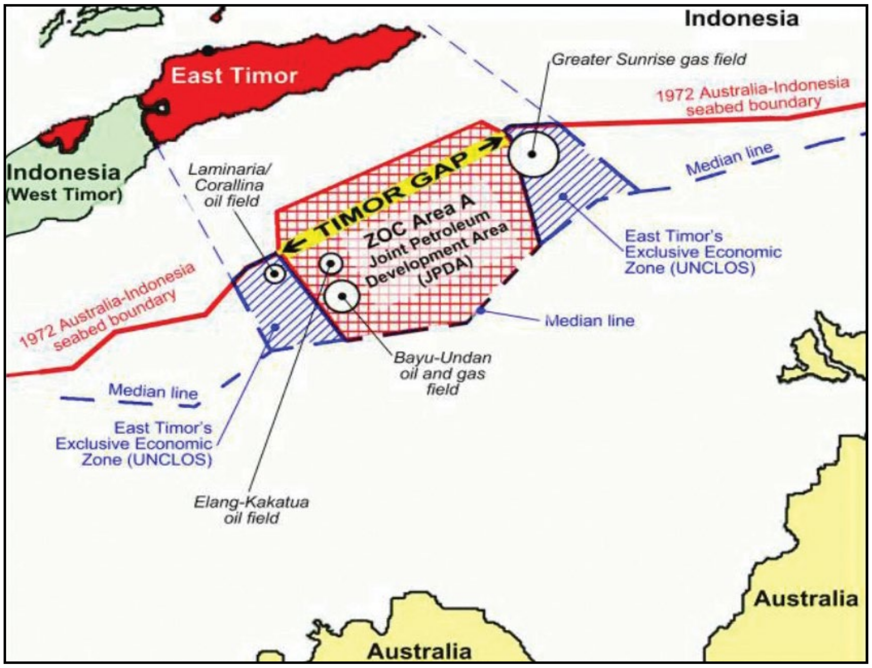
- Elang Kakatua – production in 1998 to 2006
- Bayu Undan – production since 2004 - estimated to stop in 2022 (may be longer)
- Kitan – production in 2011 and suspended operations in 2015 (can start operations again).

In 2005/2006, the first bidding round was done for exploration blocks in JPDA and Offshore Exclusive areas. Marine exploration activities for oil and gas in Timor Sea are still in progress. Oil and gas fields in the Timor Sea (Elang-Kakatua Bayu-Undan Chudditch Kuda Tasi Jahal; Greater Sunrise; and Laminaria-Corallina Buffalo in Timor-Leste's side of the median line; Evans Shoal Petrel-Tern Blacktip in the Australia side of the median line) have an estimated reserve of 4.840 billion of Barrel Oil Equivalent (BOE) (Wirasantosa, et al. 2011). There are no explorations onshore or inland.

Potential value of oil to be explored and developed in the next 50 years:

- Timor-Leste's total Petroleum Initial-In-Place (PIIP) is in the range of 12-17 billion BOE
- TIMOR GAP estimates the recoverable resources will be around 6.3 billion BOE (as a comparison, Bayu Undan reserve is ~ 1 billion BOE)
- The monetary value of these resources at an average of US$ 59 per barrel in the next 50 years is US$ 372 billion.

Figure 8.6: Oil and Gas Exploration in Timor-Leste.



Source: The La'o Hamutuk Bull. V.4, no. 3-4, August 2003 in Wirasantosa, et al., 2011.

Revenues received in the form of royalties, profit and taxes from petroleum have been supporting the development of the country with its annual budget contribution. The oil and gas sector contributes two-thirds of the GDP.

Approximately US$ 87.4 million were collected from petroleum tax revenues during the period of January to December 2016. The overall total petroleum collection figures have decreased from the previous tax year, from US$ 461.2 million to US$ 87.4 million. The collection decline in 2016 (81%) was a result of the global decline in oil prices, and the assessment of the actual income tax liability of some contractors, which revealed to be lower than the estimated income tax liability for the 2014 and 2015 tax years. Such assessment, which determined that the contractors made tax overpayments, resulted in tax credits that had to be granted to the contractors. Consequently, the contractors offset those 2014 and 2015 tax credits against their 2016 income tax liabilities. This situation may continue to occur in the 2017 tax year, since some of the contractors' overpayments have not been totally offset yet. This is part of the ongoing fiscal reform process.

Potential US$ 372 billion worth of resources are yet to be monetized in the next 50 years. This requires exploration, development, and maintenance worth US$ 222 billion in the next 50 years. When fully explored, approximately US$ 31 billion worth of income may be acquired by the government through taxes and profits from oil (upstream take), plus TIMOR GAP dividends of around US$16 billion.

Investment opportunities. To capture the full value, however, Timor-Leste should move from an upstream, extractive-oriented industry to more of a transformational industry by way of developing services; manufacturing of fabrications and goods, and establishing the Suai Supply Base, refineries/ petrochemicals, and LNG plant. This will ensure that around 27 percent of the US$ 100 billion is captured in Timor-Leste's economy with additional multiplier effects, creation of thousands of jobs, increased trade, commerce, and SME development, and overall sustained GDP growth in the next 20 years or so. The government can take around US$ 16 billion from the downstream services, including TIMOR GAP dividends. However, this requires state investment of up to US$ 2.2 Billion (in Suai Airport, Suai Supply Base, Highway), and the rest by commercial entities.

Viet Nam

Viet Nam's oil and gas industry was formed right after the country's unification, but until mid-1986 the first tonnes of crude oil were extracted from the Bach Ho field at the continental shelf of Viet Nam, bringing Viet Nam in the list of oil and gas producing countries in the world. Since 2006, many new oil and gas fields have been explored and discovered (such as Dai Hung, White Rhino, Su Tu Nau, White Rabbit, Diamond, Thien Ung). However, the annual crude oil production increased slowly and has tendency to decrease in recent years.

In addition to oil and gas exploitation, Viet Nam has developed petrochemical refineries.

Dung Quat oil refinery (put into operation in 2010) has the capacity of 6.5 million tonnes/year. Dung Quat polypropylene factory has the capacity of 150,000 tonnes/year. A number of small-scale processing plants, such as condensate processing plant, Cat Lai (Ho Chi Minh City), Cai Mep (Ba Ria - Vung Tau), Nam Viet (Can Tho), Dong Phuong (Can Tho), annually provide 0.5-1 million tonnes of gasoline for domestic demand.

Nghi Son Petrochemical Complex (NSRP), which has a capacity of 10 million tonnes/year (equivalent to 200,000 barrels/day) with a source of material being 100% of heavy crude oil imported from Kuwait, was put into operation in the fourth quarter of 2018.

Binh Son Oil Refinery of the Petrochemical Joint Stock Company (BSR) is operating safely, stably and efficiently with a processing capacity of 6.5 million tonnes of crude oil/year, equivalent to 148,000 barrels/day meeting more than 30 percent of gasoline demand nationwide.

The plants producing nitrogenous fertilizer from gas, including **Phu My** and **Ca Mau**, have total capacity of over 1.5 million tonnes/year, meeting 70-75% of the domestic urea demand annually.

The contribution of the oil and gas industry (including oil and gas exploitation and processing) to GDP was quite high and stable in the period of 2008 - 2013, with an average contribution of over 22 percent; then decreased to an average of 8.35 percent between 2014 and 2015, and further went down to 3.79 percent in 2016, and to 2.76 percent in 2017. The value of industrial production (in 2010 constant prices) reached VND 519.8 trillion in 2019. **PetroVietnam** (PVN) contributed about VND 108,039 trillion to the State budget in 2019, an increase of VND 13.23 trillion from 2018.

8.2 Risks Facing the Oil and Gas Industry

Despite all the advances in green and renewable energy, oil and gas still make the world go round.

Offshore drilling uses huge fixed or floating platforms to extract oil and natural gas reserves from beneath the ocean. The dangers posed by offshore oil and gas production include:

- **Oil pollution**: Spills from platforms, pipelines, tankers, and coastal facilities release barrels of oil every year, posing risks to the coastal and marine areas, major habitats and wildlife, and to livelihoods and the economy.
- **Toxic pollution**: Normal offshore drilling operations release toxic pollution into the air and water. Exploration and drilling at the platform, transportation via tankers, and refining the oil on land can all release volatile organic compounds (VOCs), GHG, and other air pollutants.
- **Risk to ecosystems**: A major spill could devastate beaches, wetlands, mangroves, mudflats, marshes, seagrass, and coral reefs.
- **Risk to animals**: Wherever there are oil spills and excess pollutants, wildlife is at risk. It would poison and debilitate fish, oysters, crabs, seabirds, marine mammals, and other wildlife.

- **Risk to other industries**: When offshore drilling is introduced into a region, it jeopardizes municipal/artisanal and commercial fishing, recreation, and tourist economies, affecting livelihoods and income from these industries.
- **Impact on climate change**: *a threat we simply cannot afford to ignore*. This is a time when we should be turning towards renewable energy alternatives, energy efficiencies, and conservation, and not perpetuating our dependence on fossil fuels.

8.3 Oil Spill Prevention and Response

An increased risk of oil spills necessitates an increase in the capability to respond and manage major oil spill incidents. Most of the countries in the region have been successful in establishing the elements of preparedness advocated by the International Convention on Oil Pollution Preparedness Response and Cooperation (OPRC).

Even though the Southeast Asian region has made some notable progress over the past few decades in terms of oil spill preparedness and response, the region's capabilities are arguably less mature compared to other parts of the world. Recent oil spill incidents in the region have revealed a need for greater collaboration between the government and industry stakeholders from oil, shipping and port industries, on planning, capacity building, preparing for, and responding to major transboundary oil spill incidents and alignment of oil spill preparedness and response system of a country from the national to provincial level.

Malampaya natural gas field. *(Photo by DOE Philippines)*

9 Marine Renewable Energy: Powering the Future

"Pray, look better, sir... those things yonder are no giants, but windmills."
Miguel de Cervantes

Over the next ten years, East Asia's energy demands are expected to increase by 50 percent due to a rapidly growing economy, and over that same period, external costs related to air pollution from the combustion of fossil fuels will increase by 35 percent (to US$ 225 billion in 2025) and energy-related CO_2 emissions are expected to increase by 61 percent under a business-as-usual scenario. Land-based solar and wind energy are mature forms of renewable energy (RE) technology, and they continue to improve over time. They have benefitted from favorable policies that have allowed them to advance, in some cases, to be price-comparable with fossil fuels, without government assistance. Yet East Asia's unique geography increasingly points towards incorporating ocean-based renewable energy as a part of the renewable energy mix. Policymakers can rely on a blend of existing policy tools that have helped spur land (and water) based solar and wind energy to the forefront, as well as other policy tools to spur more emerging forms of ocean-based energy, in order to meet climate change related regional and national goals.

Ocean Energy Development in RO Korea since 2000

Source: KIOST 2017.

9.1 Ocean Energy

In the face of rising concerns over global climate change, the challenge is how to source clean energy sustainably. Increased use of clean energy (through renewable energy and energy efficiency) is also in the direct interest of poor countries by providing clean, cheap, and reliable access to electricity. It presents emerging economies with the opportunity to address their long-term future by selecting a less carbon-intensive path to growth.

Ocean energy offers an alternative to fossil-fired power plants. It has considerable long-term potential for economic growth, energy security and job creation. Ocean energy can be exploited from a number of conversion methods, such as wave power, hydrokinetic energy from tides and ocean currents, tidal barrage, ocean thermal energy conversion (OTEC), and salinity gradients.

Countries cannot develop without widespread access to reliable and affordable electricity. The projected growth rate of GDP in Asia and the Pacific at 3.5 percent per year through 2030 is the highest in the world, driving an increasing demand for energy. Reliable energy supply is vital in improving living conditions. Yet, studies (World Bank) show that 1.5 billion people—more than 20 percent of the global population—live without access to electricity, and far more live with expensive, unreliable power supplies. Up to 3 billion more people rely on burning wood and other solid fuels for heating and cooking. In the face of rising concerns over global climate change, the challenge is how to source clean energy sustainably. Increased use of clean energy (through renewable energy and energy efficiency) is also in the direct interest of poor countries by providing clean, cheap, and reliable access to electricity. It presents emerging economies with the opportunity to address their long-term future by selecting a less carbon-intensive path to growth. A range of renewable energy technologies exists to take advantage of the various natural resources that may exist in any given location: wind, tidal, solar power can each be harnessed in a cost-effective and sustainable way when the right conditions exist, and the right approach is taken.

Although ocean energy technologies are at an early stage of development, there are encouraging signs that the investment cost of technologies and levelized cost of electricity generated will decline from their present non-competitive levels as R&D and demonstration projects proceed, and as deployment occurs.[133]

Ocean energy technologies could be used to supply electricity for direct potable water production or to meet thermal energy needs.[134]

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[133] Lewis, *et al.*, 2011.
[134] Lewis, *et al.*, 2011.

Country initiatives

RO Korea

Since 2000, the South Korean government has operated the National Research and Development (R&D) Program for the development of technologies on tidal power (barrage), tidal current energy, wave energy, and OTEC. RO Korea issued the 4th *New and Renewable Energy Master Plan 2014-2015*, which includes the goal for ocean energy, and the *Mid-term and Long-Term Clean Ocean Energy Development Plan 2016-2025*, which sets up the R&D support plan, including enhancing infrastructure; accelerating commercial development; open sea testing for wave and current energy; and collaborating with South Pacific islands for OTEC.[135] There is also an education program for training professionals in the ocean energy development.

The main funding institutions are the Ministry of Oceans and Fisheries (MOF) and Ministry of Trade, Industry and Energy (MOTIE). MOF funds the demonstration projects under the "Practical Ocean Energy Technology Development Programme", while MOTIE is in charge of the R&D projects under the "New and Renewable Technology Development Programme". Participation of the private sector has been increasing also. Incentives to support renewable energy include: Feed-in-tariff (FiT) which supports the tidal barrage power; Renewable Energy Certificate (REC) with variable weights; Renewable Energy Portfolio Standard (REPS).

The REPS was established in 2012 to enforce utility companies with a capacity of over 500 MW to provide an obligatory portion of the total electricity production with renewable energy, which was 4.0 percent in 2016.[136]

An innovative market incentive is the tradable Renewable Energy Certificate (REC), which supplements the REPS policy. The value of the REC policy varies on the type of generated resource, and other factors, such as distance from the coastline, capacity or installation method. For example, the REC of a tidal barrage with embankment is 1.0, while the one without embankment is 2.0. The REC value for tidal current is 2.0, and an increase is being considered to accelerate the market development. The inclusion of wave and OTEC in REC policy is under discussion.

The R&D program has resulted in the construction of the Uldolmok Tidal Current Power Pilot Plant (1MW) in 2009, Sihwa Tidal Power Plant (254MW) in 2011, hybrid-OTEC power plant using multiple heat sources (200kW) in 2014, and Jeju Wave Power Pilot Plant in 2015.[137]

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135 OES, 2014.
136 OES, 2016.
137 PEMSEA, 2015; Lee, 2015.

The first Tidal Current Power Project, with a capacity of 1MW was piloted in the Uldolmok channel. The project started in 1986 involving a series of comprehensive field measurements and numerical modelling.

The Shihwa Tidal Power Plant, the largest in the world, has ten 25.4-MW turbines that can generate a total capacity of 254 MW, with an annual generation of 552.7 GW, which can supply energy to around 200,000 residents.[138] To ensure enough water circulation, eight culvert type sluice gates were also constructed. The project was started in 2003, and cost about US$ 355 million. The Shiwa Tidal Power Plant will help boost RoKorea's energy self-sufficiency and contribute to cutting down oil imports by 862,000 barrels per year and reducing the emission of carbon dioxide by 315,000 tons per year.[139] It also enhanced the economy by forming waterfront and tourist attraction.

Japan

In 2016, under a project of Japan's New Energy and Industrial Technology Development (NEDO), an ocean tidal current project has been undertaken by IHI Corporation, Tokyo University, Mitsui & Co., Lt., with a target of operation in 2017. The system is a twin-type configured with a pair of 50 kW power generators. The system is assumed to be 2 MW (two 1000 kW units) with a turbine of about 40 m. the targeted generation cost is 20 yen per kWh.

A consortium consisting of Kyuden Mirai Energy Co., Inc., Nippon Steel & Sumikin Engineering Co., Ltd., NPO Nagasaki Marine Industry Cluster Promotion Association and Open Hydro Technology has been selected by the Ministry of Environment (MOE) of Japan to supply a tidal turbine system for installation in the Okinawase Seto area of Goshima City, Nagasaki. This 2-MW demonstration project aims to establish technologies conforming to domestic environments and technical standards.

There are still challenges for the successful commercialization of ocean energy, such as financial risk, technological uncertainties, grid-connection problems, etc.

The Japanese government enacted the *Ocean Basic Law* in July 2007, and based on this, the cabinet later issued the *Basic Plan on Ocean Policy* (BPOP) in March 2008, and the *Second Basic Plan on Ocean Policy 2013-2018* in April 2013. Under the section of the BPOP 'Utilization of the Sea' renewable ocean energy has been planned, including wave energy, tidal energy, ocean current energy, and ocean thermal energy. The renewable ocean energy projects are supported by NEDO, MOE, and Ministry of Education, Culture, Sports, Science and Technology (MEXT).

[138] Sang-Hoon Kim, 2009.
[139] Sang-Hoon Kim, 2009.

China

In 2016, the Chinese government released the *Outline of the 13th Five-Year Plan for Economic and Social Development*, emphasizing the development of blue economy, protecting the marine environment, and responding to global climate change. The State Council of PR China adopted a *Strategic Action Plan for Energy Development 2014 – 2020*, which includes lowering coal energy consumption, increasing the non-fossil energy consumption by 15 percent, and forming clean, efficient, safe, and sustainable energy supply system. The *Action Plan for Energy Technology Revolution and Innovation 2016-2030*, released by the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) in March 2016, aims to develop MRE demonstration projects and establish a supply chain for MRE by 2030.

The State Oceanic Administration (SOA) released the *Outline of Marine Renewable Energy (MRE) Development 2013-2016*, which includes improving devices and technology readiness levels, build demonstration projects, construct public service for MRE industrialization, and enhance the MRE resources zoning in China. SOA also released the 13th Five-Year Plan 2016-2020 for MRE, which aims to construct three MRE industrial parks, and develop 6-8 island projects for multi-energy complementary power supply based on MRE with a target of 50 MW by 2020.[140]

From 2010-2014, the Special Funding Program for MRE (SFPMRE) sponsored by the Ministry of Finance (MOF) and SOA received around RMB 800 million, and more than 90 MRE projects were supported. A budget of RMB 100 million (US$ 15 million) has been granted in 2016 to support six projects involving tidal current energy and wave energy.

Singapore

Singapore awarded S$15 million worth of research grants to develop energy generation and micro-grid systems to researchers in the country. One of the projects that got funding was the *Flexible Distributed Generation using Tidal In-stream Energy System for Remote Island Applications* by the Energy Research Institute at the Nanyang Technology University (ERI@N). A turbine will be developed for topical sea waters, which have lower tidal flows compared to the tidal energy hotspots in Canada and northern European countries.[141]

On the commercial front, developments in tidal energy have been championed by Atlantis Resources Corporation (headquarters are located in Singapore). Hann-Ocean Pte Ltd has developed the Drakoo (dragon king of ocean) wave energy converter for deployment in Singapore.

[140] OES, 2016.
[141] OES, 2014.

The Energy Market Authority of Singapore organizes the annual Singapore International Energy Week (SIEW). In 2016, The Asian Wave and Tidal Energy Conference (**AWTEC**) was conducted as part of the SIEW. The AWTEC has been established as the regional conference affiliated with the European Wave and Tidal Energy Conference (EWTEC) series to facilitate the transnational and regional sharing of knowledge on wave and tidal renewable energy systems, their interactions with the environment and the identification of barriers to establishing the marine renewable energy industry.

ERI@N also set up the Southeast Asian Collaboration on Ocean Renewable Energy (SEAcORE) to understand the regional energy needs and ocean energy technology challenges specific to tropical countries. The ASEAN Center of Energy (ACE) made the ERI@N-SEAcORE as the Technical Working Group to assist in the conduct of joint projects (e.g., resource mapping and assessment), promote the creation of new markets with partner industrial firms, and facilitate the adoption of ocean renewable energy in the Southeast Asian region.[142]

Philippines

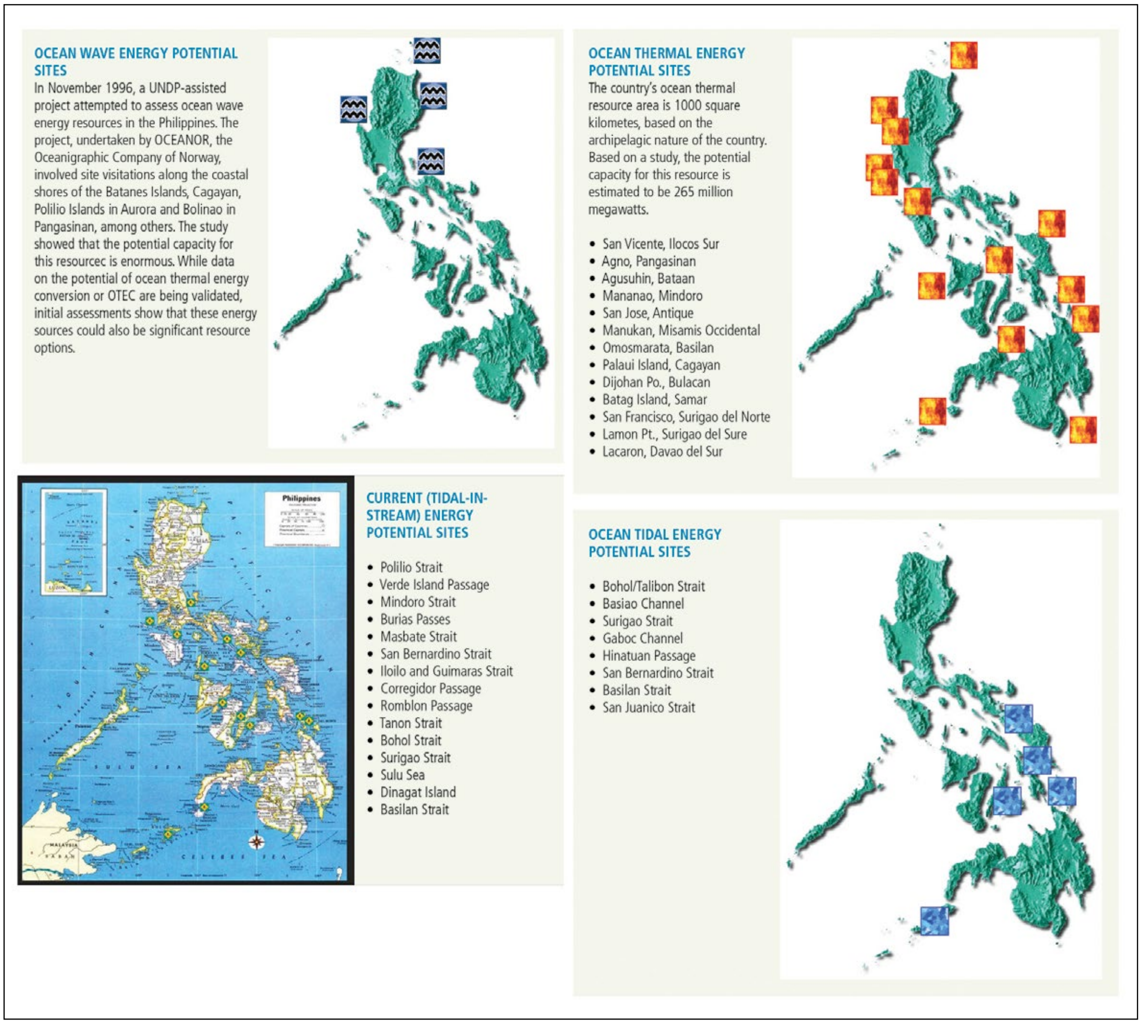
Ocean energy in the country can come from various sources: wave, currents, tides, and thermal. Harnessing ocean energy in the country is still in its infant stages, however, potential sites have already been identified (**Figure 9.1**). The potential capacity for ocean thermal energy is estimated to be 265 million megawatts.

Indonesia

The potential for marine power generation in Indonesia averages 35 kW per meter of coastline (Bappenas, 2016).[143] Indonesia has a coastline of 99,000 km; 10 percent of it could potentially produce 280 Gigawatt of power. Using electricity prices by PLN in December 2016, the acceptance of marine energy at IDR 410.84 billion per year, and a profit margin of 75 percent, the annual profit for wave energy can reach IDR 308.13 billion (=US$ 23.15 million) per year. Carbon credits generated is approximately IDR 60 million per year based on the average CO_2 emissions of fossil energy plants with a capacity of approximately 1,000 tonnes of CO_2. The potential sites for wave and tidal energy, and OTEC are shown in **Figure 9.2**.

142 OES, 2014.
143 http://perpustakaan.bappenas.go.id/lontar/file?file=digital/110743-%5B_Konten_%5D-L.323.%20Bab.%202%20Perkembangan%20Energi%20Arus.pdf

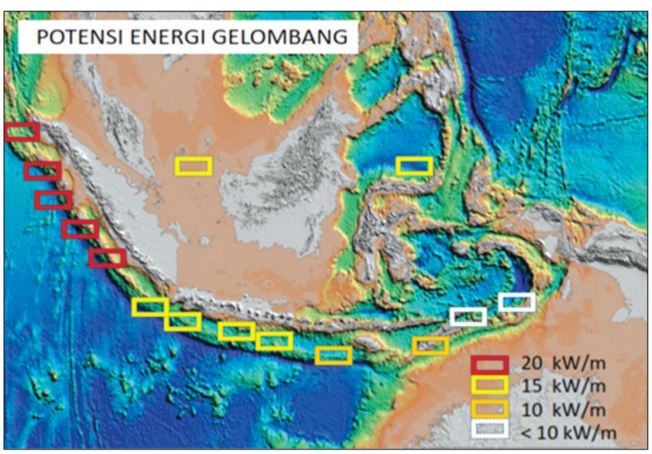
Figure 9.1: Potential Sites for Wave, Tidal, Current and Thermal Ocean Energy in the Philippines.



Source: Department of Energy.

Figure 9.2: Potential Sites for Wave, Tidal, and Thermal Ocean Energy in Indonesia.

Wave Energy



Tidal Energy

OTEC

Source : Direktorat EBTKE, Kementerian ESDM, Tahun 2014.

9.2 Coastal and Offshore Wind Power and Solar Farms

China

In terms of market incentives, the Notice on Feed-in Tariffs (FiT) for offshore wind power was released by the National Development Reform Commission (NDRC) of China in June 2014. The FiT for non-binding offshore wind power projects was RMB 0.75-0.85 before 2017, and the FiT for licensed offshore wind power projects cannot be higher than these prices.

For offshore wind power generation, China has total installed capacity of 2,146 MW as of mid-2021. China supports feed-in tariffs (FiTs) for electricity from RE sources, charges energy-intensive industry higher rates for electricity, and has also piloted an emissions cap-and-trade scheme that incentivizes low-emission energy generation technologies. It is leading the region on RE policy. In January 2017, China's National Energy Administration ordered a halt on the construction of over 100 coal-fired power plants (across 11 provinces) with a combined installed capacity of over 100 gigawatts (GW). It is the global leader in offshore wind power and floating solar projects.

In June 2017, China completed the largest floating solar power plant in the world at 40 MW, and by the end of 2017, it finished another 70-MW floating solar project. This facility also has a restorative feature in that it can also clean the water on which it is floating, and reduce evaporation losses.

Singapore is reportedly exploring the idea of installing solar floating panels offshore to power its data centers. Other offshore wind projects are in South Korea (99MW), and Japan (56MW).

Philippines

In the *National Renewable Energy Program 2011-2030*, the government targets to harness a total of 2,345 MW from wind and 350 MW from solar power. Technology in wind and solar electricity generation has advanced while the cost has been drastically reduced, thereby enabling these clean renewable energy sources to now compete with coal, and help in reducing GHG emissions.

The Philippines is the largest wind power generator in ASEAN as of 2017. Wind power has gained traction, with installed capacity of 427 MW, and 66 awarded projects in 2017 with potential capacity of 2,461.5 MW. The country's wind energy sector has significant potential and could provide up to 76 GW of power. The recent developments are: the Bangui Wind Farm, Burgos Wind Farm, and Caparispisan Wind Farm in Ilocos Norte; the Wind Energy Power System near Puerto Galera, Oriental Mindoro; San Lorenzo Wind Farm in Guimaras; Nabas Wind Farm in Aklan; and Pililla Wind Farm in Rizal. Most of these wind farms are located in coastal municipalities, and they have become tourist attractions as well. Offshore wind farms are also in the pipeline.

Thailand

There were several types of alternative sources of energy, such as solar energy, wind energy, small hydro power, large hydro power, biomass, biogas, and biofuels (ethanol and biodiesel) being promoted by the Department of Alternative Energy Development and Efficiency. In 2015, electricity generation from alternative energy was 7,963 MW, of which 234 MW or 2.9 percent was produced from wind energy.

The investment value of wind farms in the whole country was US$ 0.95 billion (Alternative Energy Development and Efficiency, 2015). In 2015, wind farm distribution in 12 coastal provinces had a total capacity of 16.02 MW. The biggest coastal wind farm was in Nakhon Si Thammarat (11.75 MW), Songkhla (1.53 MW), and Rayong (1.02 MW).

Viet Nam

Research by the World Bank shows that Viet Nam has a great advantage in wind due to a long coastline of more than 3000 km and many islands where an average wind speed is of five meters per second (5 m/s) or more at altitude of 65 m high the whole year, equivalent to a total capacity of 512 GW. In particular, more than eight percent (8%) of Viet Nam's area is ranked as having very good wind potential (wind speed of 7-8 m/sec at the altitude of 65 m), that can generate more than 110 GW.

Currently, there are nine wind farms operating with a total capacity of 304.6 MW, of which the largest one is the Bac Liêu offshore wind farm, with capacity of nearly 100 MW, while the smallest is the Phu Quy wind farm, with capacity of 6 MW farm connected to independent grid (not to the national grid) on Phu Quy island, Binh Thuan province, and the rest are seven wind power plants with small capacity of less than 50 MW.[144] The Bac Liêu wind farm is being studied for the proposed increase to 1,000 MW (10 times more) by 2025.

Bac Liêu wind power farm in the Mekong Delta. *(Photo: Shansov.net, CC BY-SA 3.0)*

[144] Viet Nam Electricity (EVN); NSOC Report of Viet Nam, 2020.

9.3 Supporting Policies

Most of the supporting policies are for RD&D grants for renewable energy technologies. **Table 9.1** shows the policies enabling the deployment and installation of renewable energy facilities in selected countries by end of 2010. There are lessons learned from the implementation of these policies. Some countries in the EAS region have recognized the potential of marine renewable energy, and have adopted supporting policies and action plans for ocean energy and renewable energy development in the region. According to the International Energy Agency (2021), 80 GW of offshore wind will need to be added globally each year by 2030 to set the world on course for reaching net zero emissions by 2050. Governments must ensure that the right policies and clear targets are in place to spur faster and increased offshore wind and ocean energy deployment.

Table 9.1: Examples of Renewable Energy-Specific Policies.

Policy Instrument	Country	Example Description
Capacity or Generation Targets		
Aspiration Targets and Forecasts	UK Spain (Basque Government) Canada	3% of UK electricity from ocean energy by 2020 5 MW off Basque coast by 2020 Canada is developing a roadmap for 2050 (Ocean Renewable Energy Group)[1]
Legislated Targets (Total Energy or Electricity)	 Ireland Portugal	Specific targets for marine energy installations 500 MW by 2020 Ireland 500 MW by 2020 off Portugal
Capital Grants and Financial Incentives		
R&D Programs/Grants	USA China	US Department of Energy Wind and Water Power Program (capital grants for R& D and market acceleration) High Tech Research and Development Programme (#863)
Prototype Deployment Capital Grants	UK New Zealand China	Marine Renewables Proving Fund Marine Energy Deployment Fund Ocean Energy Major Projects
Prizes	Scotland	Saltire Prize (GBP 10 million for first ocean energy device to deliver over 100 GWh of electricity over a continuous two-year period)
Market Incentives		
Feed-in Tariffs	Portugal Ireland/Germany	Guaranteed price (in $/kWh or equivalent) for ocean energy-generated electricity
Tradable Certificates and Renewable Obligation	UK	Renewable Obligation Scheme - tradable certificates (in $/MWh or equivalent) for ocean energy-generated electricity
Industry Development		
Industry and Regional Development Grants	Scotland, UK and others	Cluster developments
Industry Association Support	Ireland New Zealand	Government financial support for establishment of industry associations

Table 9.1: Examples of Renewable Energy-Specific Policies. (cont.)

Policy Instrument	Country	Example Description
Research and Testing Facilities and Infrastructure		
National Marine Energy Centres	USA	Two Centres established (Oregon/Washington for wave/tidal and Hawaii for OTEC/wave)
Marine Energy Testing Centres	Scotland, Canada and others	European marine Energy Centre[2] and Fundy Ocean Research Centre for Energy, Canada[3]
Offshore Hubs	UK	Wave hub, connection infrastructure for devices
Permitting/Space/Resource Allocation Regimes, Standards and Protocols		
Standards/Protocols	Internation Eletrotechnical Commission	Development of internartional standards for wave, tidal and ocean currents
Permitting Regimes	UK	Crown Estate competitive tender for Pentland Firth licenses
Space/Resource Allocation Regimes	USA	Department of Interior permitting regime in US Outer Continental Shelf

Notes: [1] See ww.oreg.ca for description of roadmap. [2] See www.emecs.org.uk for description of centre. [3] See www. fundy force.ca for description of centre.
Source: Lewis et al. 2011. (Modified from Huckerby and McComb, 2008)

Lessons Learned in Marine Renewable Energy

The examples of policy innovations together with ocean energy and wind power development can be a foundation upon which to build a regional blue economy plan for the EAS marine renewable energy. The plan could consider the following elements:

- Taking stock of how governments will meet their climate commitments and protect their people from pollution by evaluating RE possibilities on land and in water. More mature technologies generally benefit from market-based incentives, such as FiTs. Emerging technologies generally benefit from expenditure support policies that provide capital up front, though have also benefitted from FiTs.
- Pursuing technologies that most fit with their geography and current level of expertise in the field. For example, it is far more rewarding from an environmental and economic perspective to invest in tried-and-true technologies, such as onshore and offshore wind and solar, and possibly explore tidal energy only if geographically appropriate, cost-effective, and environmentally sound.
- Investing in improved infrastructure and a smart grid to ensure that these variable and distributed sources of renewable energy can be used to their fullest potential.
- Supporting research and testbed platforms for marine renewable energy to substantiate investments in commercial options, including commercial-scale wave or OTEC energy.

Offshore wind power project of China Three Gorges Corp (CTG) in Fujian Province *(Photo courtesy of CTG)*

Windmills in Bangui, Ilocos Norte, Philippines *(Photo by Jose C. Morales, Jr.)*

10 Emerging Sectors of the Blue Economy: Ocean of Opportunities

"The rewards for biotechnology are tremendous - to solve disease, eliminate poverty, age gracefully. It sounds so much cooler than Facebook."
George M. Church, Ph.D.

10.1 Marine Biotechnology

Recent advances in biotechnology are contributing to meet society's most pressing challenges and achieve key UN SDGs. Marine biotechnology can contribute to food, water, and energy security, pollution mitigation, climate action, and health care. It deals with:

- ocean exploration for development of new pharmaceutical drugs, chemical products, enzymes, and other products and processes
- advancing aquaculture and seafood safety
- improving bioremediation for water pollution reduction
- dealing with the plastics threat by using marine organisms to produce eco-friendly chemicals like biopolymers
- developing microbial energy and biofuels (from both micro and macro algae) as environmentally friendly alternative energy source to crude oil and gas

The global market for marine biotechnology is projected to reach US$ 6.1 billion by 2025, driven by the rise of "circular economy" as the blueprint for a new sustainable economy in the 21st century.[145]

Marine biomaterials (including seaweed hydrocolloids) could contribute over 40 percent, and marine bioactives for healthcare would be the most important and fastest-growing sector.[146] The size of this, even if it is an over-estimate, suggests that the harnessing of marine bioresources through biotechnology and development of products and services should be a serious target for any country with significant marine biodiversity.

Malaysia and Thailand allocated funds to biotechnology development. In China, biotechnology is an integral part of the Five-Year Plans. However, there are few specific programs involving marine

[145] PR Newswire. "Global Marine Biotechnology Industry" (24 January 2020) (https://www.prnewswire.com/news-releases/global-marine-biotechnology-industry-300992712.html)
[146] CSA in Marine Biotechnology (https://www.marinebiotech.eu/csa-marine-biotechnology; http://www.marinespecies.org/introduced/wiki/Marine_Biotechnology_international_summary)

biotechnology. Notable are the Philippines and Viet Nam, both of which have a marine biotechnology policy or strategy. The Philippines has a National Aquatic Resources Research and Development System (NARRDS), while Viet Nam explicitly called for increased efforts in marine biotechnology through a letter issued by the President of the Viet Nam Academy of Science and Technology (VAST).

10.1.1 Biotechnology Business

RO Korea

In RO Korea, marine biotechnology supports developments in food, chemicals and medicines. The domestic marine biotechnology market in RO Korea is expected to grow more than 14 percent annually from $70 million in 2012 to $360 million in 2020, which represent a share of five percent of the world marine biotechnology market. Currently, the domestic marine biotechnology market is highly concentrated in the food sector, but it is estimated that the future development of the pharmaceutical and chemical fields will be as strong as the food sector (**Table 10.1**).

Table 10.1: Marine Biotechnology Businesses in RO Korea (2016).

Industry Classification	Number of Companies	Ratio (%)
Marine Bio Resources	4	5.5
Marine Bio Food	39	53.4
Marine Biopharmaceutical	10	13.7
Marine Biochemistry	12	16.4
Marine Bioenergy	1	1.4
Marine Bio Environment	4	5.5
Marine Biotechnology Equipment	1	1.4
Marine Bio R&D and Services	2	2.7
Total	**73**	**100.0**

Source: NSOC Report of RO Korea. 2019.

10.1.2 Marine Biotechnology and New Medicines

The ocean is considered the world's last frontier in the search for novel drugs from nature for serious human diseases, such as cancer, HIV/AIDS, tuberculosis, and drug-resistant infections.

China

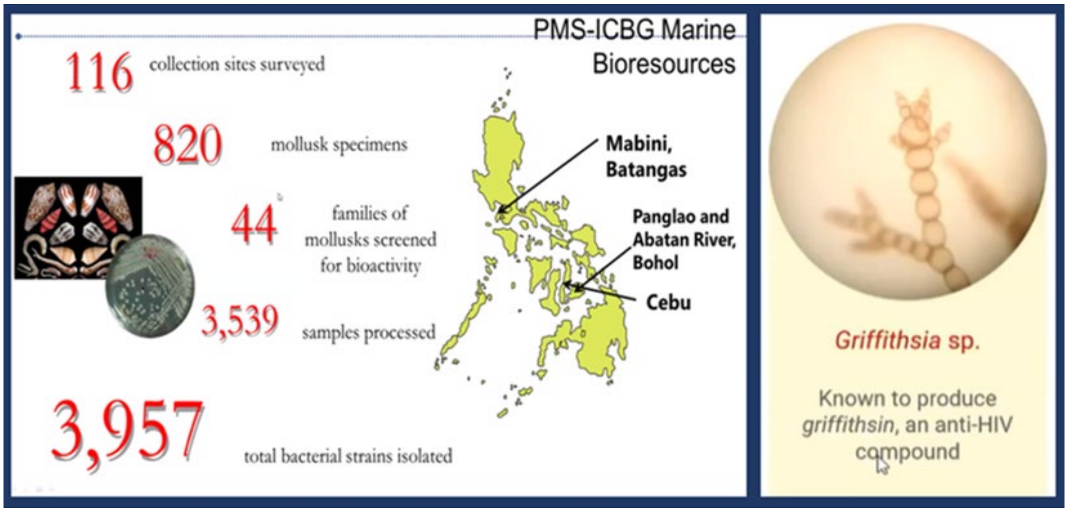
Marine natural products (MNPs) in China have been traditionally used in drug and food development. MNPs have also been used in novel materials, pesticides, and environmental protection. In coastal cities of China, institutes of MNP chemistry have been established to conduct research and develop new medicines (PEMSEA, 2015; Xu, 2015).

The marine pharmaceuticals and biological products industry, as a strategic emerging industry, has developed rapidly in recent years, with the successful development of a number of marine biological products for agricultural use, marine biological materials, marine cosmetics and marine functional foods, health care products and so on. The development of biopharmaceutical products is progressing smoothly toward higher end products, enhancing the industrial chain's extension. The marine pharmaceuticals and biological products industry accounted for about 1 percent of the total GDP of core marine industries in 2015.

China has made remarkable progress in the marine biotechnology industry, having discovered a number of novel marine pharmaceuticals for treatment of tumor, AIDS, cardiovascular diseases, neurodegenerative diseases and atherosclerosis, under different stages of clinical study. By now, a number of marine drugs have been approved by the State Council for marketing, including *Duo-Xi-Kang*, *Jiao-Bie-Xi*, tetrodotoxin, propylene glyeol alginate sodium-sulfate, *Gan-Tang-Kun-Yan-Suan Gan-Lu-Chun*. Phase II clinical study has been completed for the national class-1 drug *Ti-Qu-Duo-Xin* (tetrodotoxin) for drug rehabilitation. The national class-2 novel drug "marine biological antiviral glycoprotein" has entered phase III clinical study. The early renal injury diagnostic kit has entered 3A hospitals, and its domestic market share has kept increasing for years. At present, there are dozens of research institutes and hundreds of development and production enterprises for marine pharmaceuticals in China.

Philippines

The *PharmaSeas Drug Discovery Program*—funded by the Philippines under the NARRDS—is tapping the rich marine biodiversity in the Philippines to develop new drugs. Scientists are using biotechnology to make copies of the marine compounds in the laboratory, so they do



not have to be constantly harvested from marine life. The program is focused on bioactives from marine organisms, including pain killers using sea snails, and anti-infectives from sponges.[147] Marine sponges belonging to the *Phylum Porifera* (*Metazoa*), evolutionarily the oldest animals, are the single best source of marine natural products. An endemic species of seaweed shows potential as an anti-HIV drug. The red macroalgae, *Griffithsia sp.*, was found to produce anti-HIV compounds.[148] Other species are being studied for anti-cancer uses. Some traditional medicines have also been derived from the mangroves. Their tannin contains antifungal, antibacterial, and antiviral properties. As with the other emerging and innovative ocean industries, right policies and access to financing for development, deployment and commercialization are crucial.

Coral reef monitoring
(Photo from DENR-ERDB, Philippines)

10.1.3 Biotechnology and Aquaculture

The key initiatives of the Marine Aquaculture Centre (MAC) in Singapore include the application of Recirculation Aquaculture Systems technology, with the accompanying culture protocols for intensive fry production, genetic improvement of the Asian seabass, captive breeding of new species, and the development of closed containment systems for coastal fish farms. Another example is the selective breeding project with Temasek Life Sciences Laboratory using advanced molecular biotechnology, such as marker-assisted selection technique, allowing desired traits to be selected more accurately and effectively, without any genetic modification.

In Viet Nam and Thailand, there is significant R&D programs on molecular aquaculture, especially for crustacea (shrimps, prawns).

China's first highly efficient vaccine for major diseases of marine aquaculture fish has been approved by the Ministry of Agriculture, and has been formally put into production.

10.2 Seawater Utilization and Water Security

Diminishing and contaminated water supplies vis-à-vis increasing water demands are exacerbating water scarcity in most world regions. Unconventional water resources, such as seawater and desalinated water, are expected to play a key role in narrowing the water demand-supply gap as

[147] Concepcion, 2008.
[148] Azanza and David Presentation at Mana Mo Webinar (Sept 2020).

conventional water supply systems that rely on rainfall and river runoff are no longer sufficient to meet water demands. New technologies have allowed innovative uses for seawater beyond the traditional use in cooling systems of nuclear and coal-fired power plants.

10.2.1 Desalination

Desalination is a process that takes away mineral components from saline water. Reverse osmosis (RO), low-temperature multi-effect technology, and the multi-stage flash desalination technology are the mainstream international commercial technologies used for desalination. RO produces less brine than the traditional thermal process.

Box 10.1. Five Things to Know About Desalination

1. It's a booming business. There are now almost 16,000 desalination plants operating in 177 countries, producing a volume of freshwater equivalent to almost half the average flow over the Niagara Falls.[149]
2. Several countries, such as Bahamas, Maldives and Malta, meet all their water needs through the desalination process. Saudi Arabia (population 34 million) gets about 50 per cent of its drinking water from desalination.
3. In most desalination processes, for every liter of potable water produced, about 1.5 liters of liquid polluted with chlorine and copper are created. This wastewater ("concentrate") is twice as saline as ocean water. If not properly diluted and dispersed, it may form a dense plume of toxic brine which can degrade coastal and marine ecosystems unless treated. Increased salinity and temperature can cause a decrease in the dissolved oxygen content and contribute to the formation of "dead zones", where very few marine animals can live.
4. Unconventional water resources, such as those resulting from desalination, are key to support SDG 6 (to ensure availability and sustainable management of water and sanitation for all). Seawater desalination can extend water supplies beyond what is available from the hydrological cycle, but innovation in brine management and disposal is required. Research suggests there are also economic opportunities associated with brine, such as commercial salt, metal recovery, and the use of brine in fish production systems.
5. The last decade has seen increased academic interest in recovering resources from brine, according to one study.[150] Seawater contains various minerals, some of which are rare and expensive to mine on land. While extracting materials from brine is possible, its high cost restricts commercialization.

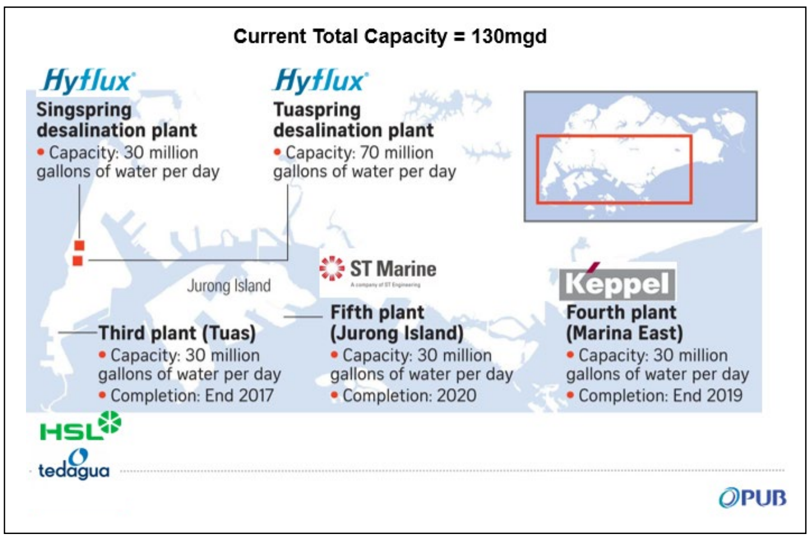
Source: UNEP 2021.

[149] Jones, *et al*., 2019.
[150] Mavukkandy, *et al*., 2019.

Augmentation of water supply

Singapore. As a small island state, water security is one of the top national agenda. Singapore was ranked 171 out of 182 countries in terms of water availability.[151] Through strategic planning, managing the complete water cycle, and investment in research and technology, Singapore has built a sustainable and diversified water supply system, which allows the country to be more resilient to weather variability. The water supply is comprised of: (a) local catchment water – "collect every drop of rain"; (b) highly treated and purified reclaimed water (called NEWater) – "collect, treat, and reuse every drop of used water"; (c) imported water (250 million gallons of water from Johor River, Malaysia); and (d) desalinated water – "collect water from the sea". As of 2018, three desalination plants (SingSpring, Tuaspring, and Tuas), with a total capacity of 130 million gallons of water a day, can meet 25 percent of Singapore's water demand (**Figure 10.1**). Residents enjoy 100 percent potable water at tap and 100 percent access to sanitation and wastewater management services.

Figure 10.1: Desalination Plants in Singapore.

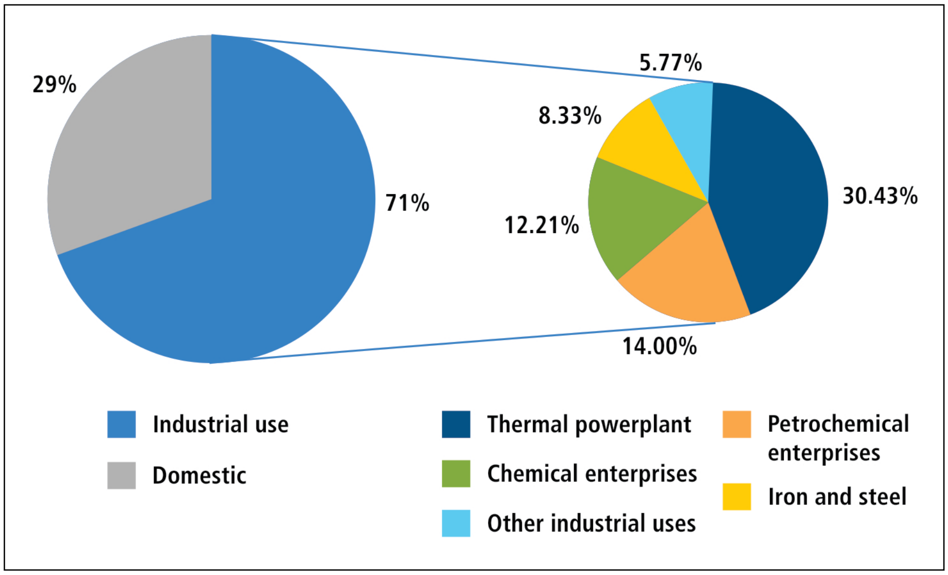


Source: www.pub.gov.sg.

China. Among the various uses of seawater in China, the largest use is industrial cooling, accounting for more than 90 percent of the total utilization of seawater, followed by desalination. The major use of desalination is for industrial use (71 percent), while 29 percent of desalinated water goes to domestic use. Desalination is widely used in coastal power, steel, and petrochemical industries. The seawater desalination projects are located in nine coastal provinces, namely, Liaoning, Tianjin, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, and Hainan, mainly in coastal cities and islands with serious shortage of water resources.

151 UN World Water Development Report, 2003.

Figure 10.2: Uses Of Desalinated Water In China.



Source: NSOC Report of China, 2018.

Risks from desalination

Realizing the vast potential of desalinated water to address water security remains a challenge due to specific barriers, such as high economic costs and a variety of environmental concerns.

Desalination is energy-intensive, and therefore has the potential to increase fossil fuel dependence, increase GHG emissions, and exacerbate climate change if renewable energy sources are not used for freshwater production.

A major environmental impact of desalination is caused by the high concentration of brine discharge. The safe disposal of effluent produced in the desalination process remains a particular concern and a major technical and economic challenge.

Brine is more than just hypersaline water—it can be loaded with heavy metals and chemicals to prevent fouling of the feedwater and messing up the complicated and expensive facility. The antifoulants used in the process, particularly in the pretreatment process of the source water, accumulate and discharge to the environment in concentrations that can potentially have damaging effects on the ecosystems.[152]

Another problem comes from the sucking in of sea water for processing. Fish, larvae, plankton or other large organism could get stuck on the intake screen.

[152] Jones, *et al*., 2019.

Mitigating the impacts of desalination

Desalination technology is rapidly evolving, so plants are getting far more efficient, both in the brine they produce and the energy they use. Environmentally safe discharge of brine can be manageable with current technology, but it is much better to recover resources from the brine and reduce the amount of brine released. This can be both economically and ecologically beneficial.

The following are some of the methods that can be applied in converting the brine into useful products using well-known and standard chemical processes:[153]

- One approach is to produce sodium hydroxide from the brine. Otherwise known as caustic soda, sodium hydroxide can be used to pretreat seawater going into the desalination plant. This changes the acidity of the water, which helps to prevent fouling of the membranes used to filter out the salty water — a major cause of interruptions and failures in RO plants.
- Another important chemical used by desalination plants and many other industrial processes is hydrochloric acid. The chemical can be used for cleaning parts of the desalination plant, but it is also widely used in chemical production and as a source of hydrogen.

In the face of increasing demand for minerals, depletion of high-grade minerals, environmental issues, and various geopolitical conflicts affecting mining, extracting the minerals from the brine produced during desalination offers an alternative solution. As explained in one study: "Seawater contains large quantities of various minerals, of which some are rare and expensive in their land-based forms. This can mitigate the mineral scarcity to some extent and reduce the desalinated water price significantly as we get an additional product from desalination. At the same time, the environmental impacts associated with the brine discharge can be avoided as well."[154]

Another example of solving this problem is utilizing the salt from the brine. In China, the brine is sent to salt fields after being processed. Cangzhou, a coastal city along the Bohai Sea of Hebei province, launched a national key project on **Desalination and Integrated Utilization of Strong Brine**. The project provides freshwater to water companies around Bohai Sea. Meanwhile, it provides concentrated salt water of 10-12 percent salinity to the surrounding salt fields. The high-concentration brine goes to salt fields after being processed using appropriate technologies, thus, reducing the evaporating time of salt fields, increasing output of crude salt, and creating eco-benefits with less human resource cost. The produced salt has industrial uses.

Nevertheless, before building expensive desalination plants, municipalities should fully implement water conservation programs, prevent pollution of water sources, and promote the reuse of treated wastewater and stormwater runoff. Treating and reusing wastewater is a more viable and environmentally sound option.

[153] Massachusetts Institute of Technology (MIT) News Office. 2019.
[154] Mavukkandy, *et al*., 2019.

10.2.2 Deep Seawater Utilization

Deep seawater refers to the water from the continental shelf to the depths of the sea that are not exposed to sunlight. It is receiving more attention as a clean and green resource. It is a renewable resource and recyclable. Deep seawater has many unique properties compared to surface seawater: (a) low temperature stability; (b) contains inorganic nutrients and salts and trace elements necessary for health; (c) cleanliness: deep seawater is free from pathogens, atmospheric chemicals, particulate suspended solids, etc.[155] The development of deep seawater is related to its utilization and applications:[156]

- In the direct utilization stage, people use the low-temperature characteristics of deep seawater to develop applications, such as OTEC for power generation, and the cleanliness characteristic for aquaculture use.
- In the primary utilization stage, people separate and concentrate deep seawater to develop drinking water and refined salt.
- In the deep processing and utilization stage, deep sea minerals are extracted and used as additives to produce high value-added food, beverage, cosmetics, and medical care products.

The United States, Japan, South Korea, and Norway have done the scientific research, produced consumer products, and established industrial chain structures related to deep seawater applications in life sciences, medicines, chemicals, beauty/cosmetics, food, aquaculture, agriculture, power generation, etc.

Deep seawater with a temperature lower than 3°C can be used in air conditioning. Cooling systems using the water are known to offer a 60 percent reduction in energy usage compared to existing solutions, and related technologies are now under development.

RO Korea[157]

Scientists estimate that the potential annual production of the deep seawater of the East Sea (Sea of Japan) is 3.97 trillion tonnes. As of 2017, the annual amount of intake of the deep seawater in the East Sea is 3.40 million tonnes. According to the Ministry of Ocean and Fisheries (MOF), deep-sea water, is the “new generation well-being water”.

in 2007, the government enacted the *Development and Management of Deep Seawater Act* to preserve, manage, develop, or use the deep seawater in an environmentally friendly manner for the future generations and the public interests, thereby contributing to the healthy life of nationals and development of related industries. Based on the act, the government established the

[155] Gao, *et al*. 2019.
[156] Gao, *et al*. 2019.
[157] The information on deep seawater utilization in RO Korea is from: Ministry of Oceans and Fisheries (RO Korea) and PEMSEA. 2019.

First Master Plan on Deep Seawater (2008-2013) in 2007, and the *Second Master Plan on Deep Seawater* (2014-2018) in 2014. To ensure stable and efficient use of the deep seawater resources, the Korean government controls the deep seawater intake area on the principle of designating "one for each city and county." By 2013, the government has authorized a total of nine deep ocean water intakes in the East Sea. To expand usage of the water, MOF, in collaboration with the Ministry of Food and Drug Safety, announced the standards for processed deep seawater in January 2015.

Deep seawater, which is full of various natural minerals and with high antioxidants, can contribute to good health. It can also be used to add flavor to food. The deep seawater for beverages accounted for about 80 percent of the deep seawater market from 2008 to 2012. There are other 69 types of deep seawater products, such as salt, confectionery, alcohol, soy sauce, tofu, and cosmetics, accounting for the remaining 20 percent.

Japan

Since 1976, Japan has carried out scientific studies of deep seawater to understand its water quality characteristics, and develop water abstraction technology. In 1989, the Marine Science and Technology Center established the Deep Water Research Institute in Kochi Prefecture and built Japan's first deep seawater abstraction and testing facility with a daily water intake of 920 tonnes. In 1999, related research and development products, such as beverage water, lotion and deep-sea algae, were introduced. As of May 2009, Japan has already built 16 deep seawater water storage facilities, mainly in Kochi, Toyama, and Okinawa prefectures. Japan has achieved a series of achievements in marine aquaculture, microalgae cultivation, beauty, beverages and food. Asahi beer is made with deep seawater, and the company has grown into the largest beer-maker in the country.

Multifaceted approach to deep seawater use in Kumejima:[158]

In Kumejima, Okinawa, multiple uses of deep seawater have helped local entrepreneurs, government, and cooperatives in starting new production activities and services, thus, stimulating the local economy.

OTEC is one of the renewable energy technologies being utilized in Kumejima using the deep seawater characteristics. The power generated with OTEC is 100 kW, supplying energy to 250 households.

Deep seawater is also distributed to experimental agriculture and aquaculture farms in Kumejima. Prawns are farmed using the clean deep seawater. It is used to farm sea grapes. Oyster farming is

[158] The information on deep seawater use in Kumejima, Okinawa is from Kobayashi, *et al*., 2018.

also experimented. The seawater is used to lower soil surface temperature and grow spinach that would not grow outside due to high aerial and soil temperature in that area.

A cosmetic company created products with the pollutant-free seawater. A spa has been opened and used for thalassotherapy.

10.3 Submarine Communications

Most of the world's communications is not carried out by satellites, but by an 'older' technology: cables under the oceans. The ocean floor is traversed by a complex network of submarine cables. These are cables laid on the seabed between land-based stations to carry telecommunication signals across stretches of ocean and sea. The submarine cable network allows greater connectivity among the people in the EAS region, and with the other parts of the world.

The cables are installed by special boats called cable-layers. The cables must generally be run across flat surfaces of the ocean floor, and care is taken to avoid coral reefs, sunken ships, fish beds, and other ecological habitats and general obstructions.

In the 1980s, fiber-optic cables were developed. These cables carry telecommunication signals across the ocean; carrying telephone, internet, and private data traffic. Fiber optic cables also enable countries to benefit from high-speed internet data. As the internet has become more mobile and wireless, the amount of data traveling across submarine cables has increased exponentially. Currently, more than 99 percent of international communications are carried over the network of fiber optic cables, most of them undersea.[159]

The maps of all submarine cables are publicly available (**Figures 10.3** and **10.4**) to avoid conflicts of use or threats to the physical integrity of these cables due to other ocean economic activities (e.g., anchoring of ships, trawling by fishing vessels, etc.). However, there are concerns that such availability can be used for cyberattacks and intentional physical attacks. The Internet is also at risk of being disrupted by sharks gnawing on the cables and by natural disasters.

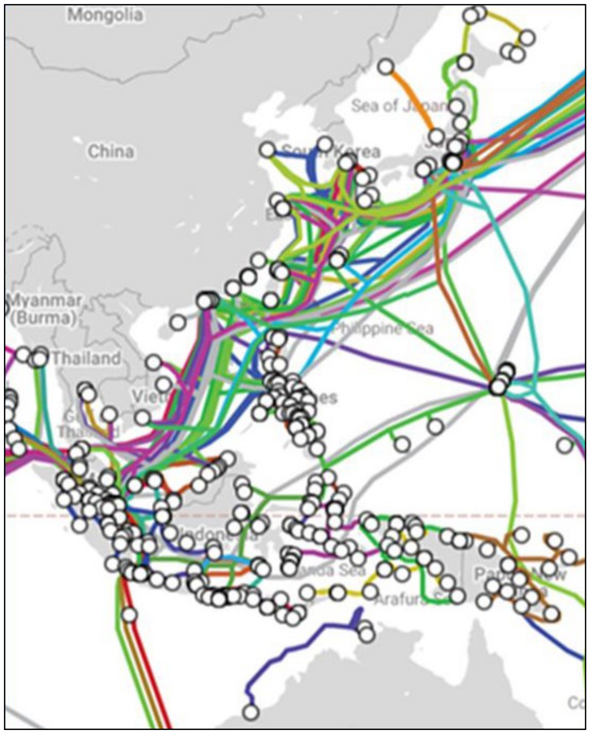
Submarine cable systems are viewed as critical infrastructure for basic communication and sharing of ideas as well as for countries looking to develop as ICT hubs and enhance their economic growth. The global digital economy is dependent on submarine cables. They do not just connect population centers, these cables now link the numerous data centers located around the world to facilitate global commerce and finance.

While the valuable contribution of the communication sector is recognized, there are no disaggregated data on the GVA of the marine communication sector and its share in the GDP of

[159] TeleGeography.

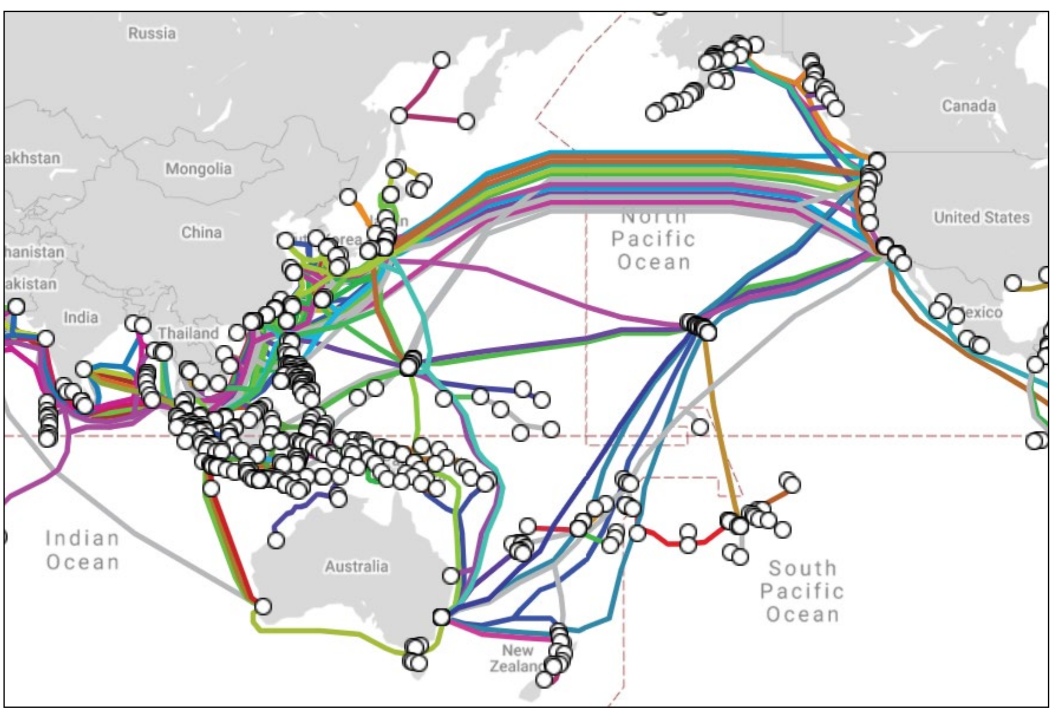
the countries in the EAS region. They carry almost all the communications and yet – in a world of wireless networking and smartphones – there is barely an awareness that they exist.

Figure 10.3: Submarine Cable Network in the EAS Region.



Source: TeleGeography (https://www.submarinecablemap.com/)

Figure 10.4: Submarine Cable Network in the Indo-Pacific Area.



Source: TeleGeography (https://www.submarinecablemap.com/)

PART 3

PROTECTING OCEAN HEALTH FOR THE BLUE ECONOMY, RESILIENCY AND WELLBEING

11 The Ocean We Have

"We are using resources as if we have two planets, not one… There can be no Plan B because there is no planet B."
Ban Ki-Moon (former UN Secretary-General)

11.1 Portents of Changing Environment and Climate

No area of the oceans is unaffected by human influence and nearly all of it (97.7 percent) is affected by multiple pressures.[160] The 'hotspots' of cumulative impact where nearly all stressors overlap are in the North Sea, South China Sea, and East China Sea.[161] The countries of the EAS region therefore have direct and tangible experience of the global decline in ocean health. Environmental costs can be quite significant as shown in **Box 11.1**. While human activities have brought economic progress, they have also caused stress to marine systems.

Activities, such as overfishing, destructive fishing, conversion of habitats, and reduction in freshwater flows, have caused the depletion of fish stocks, and changes is species composition and distribution. Siltation and sedimentation due to deforestation, mine tailings, and urban, industrial, and agricultural runoff discharged into rivers and coasts have all been known as significant sources of pollution in marine waters. Shipping, oil and gas development, spills of oil and hazardous wastes, dredging and filling, introductions of nonindigenous and invasive species, nutrient pollution, plastic waste, and marine debris have all been associated with the degradation of the marine environment and biodiversity loss. In addition, ocean acidification, ocean warming, and increasing frequency and intensity of extreme natural events (e.g., strong typhoons) can cause major perturbations in the coastal zone. This cocktail threatens marine life as well as the integrity of food chains.

Economic growth over the past 50 years in the EAS region had been rapid, but accompanied by pollution, decline in natural capital, and the compromised ability of ecosystems to sustain services. These are multiple threats that undermine the ability of the Ocean to underpin the blue economy, human well-being, resiliency, and life on Earth as we know it. In this millennium, there is growing awareness and recognition of the importance of biodiversity, water, and the environment to human wellbeing as a coupled social–ecological system.[162] However, more actions have to be done to influence political and economic decisions.

160 Halpern, *et al.*, 2008 and 2015.
161 Halpern, *et al.*, 2015.
162 Cullen-Unsworth *et al.*, 2014

Peat Swamp Forest In Pekan, Pahang *(Photo by Tan Kim Hooi)*

Box 11.1. Environmental damage assessment

- The area of coastal wetland has decreased 57 percent in China in the past 60 years. Mangrove forest and coral reef decreased by 73 percent and 80 percent, respectively.[a]
- The environmental costs from unsustainable fishing, coastal development, pollution, and climate change impacts in the Philippines amount to PhP5.7 billion or around US$ 129.5 million (2006/2009 estimates).[b]
- In Thailand, the total cost of coastal erosion, oil spills, and damage caused by tsunami amounted to US$ 2.62 billion. The cost from tsunami-related damages would have been lower if the habitats have not been degraded or destroyed by man-made activities.[c]

Sources: [a] Wen Quan, 2015; [b] World Bank, 2009; [c] Jarayabhan et al., 2009.

First, **regular monitoring of habitats, fisheries and biodiversity, marine water quality, and the land- and sea-based sources of pollution** is essential. The NSOC Reports show that most of the countries in the EAS region do not have regular monitoring of water quality of marine areas and rivers (except in some key bays and major rivers), habitat condition and species composition.

Although human pressures have been recognized, there is inadequate knowledge on spatial and temporal changes, multiple causes, and patterns of cumulative change in the region. The highly complex marine system has numerous interrelated processes acting between its physical, chemical, and biological components. The marine ecosystems are under growing pressure from human-derived climate change, over-extraction of resources, pollution (from land- and sea-based sources), and invasive species. There are a number of closely interrelated threats resulting from urbanization, industrialization, commercialisation of agriculture, and intensification of fisheries. These pressures are interacting with each other and with natural processes to cause biodiversity loss, habitat damage and fragmentation, and disease. Taken together, these pressures have cumulative effects on the marine environment. The World Ocean Assessment (WOA) I and II provide an overview of the various approaches used to measure and assess the cumulative effects of human activities and natural events and their outcomes. But more information is needed at the national and local levels, and key sites to help in identifying the pressures that are most responsible for change; the places, which are experiencing the greatest changes; and the inter-related processes and cumulative impacts.[163] Such information can be used to formulate targeted policies, action plans, and corresponding investments.

Second, further **uptake and implementation of valuation tools** is crucial to support decision-making that integrates the economic and social value of ecosystem services, which are for now provided for free by nature. The economic and welfare losses and costs resulting from unsustainable economic activities, over-exploitation of natural resources, and environmental degradation must also be analyzed since these are not explicit in the national income accounts. Making the value of our natural capital and damages to economies and society visible creates an evidence base to pave the way for more targeted and cost-effective solutions. For instance, if there are estimates of damage resulting from pollution, or ecosystems services lost due to destruction of habitats, these should be added to the GDP to reflect the overall total had these damages been prevented, including the cost of avoidance. The resulting difference in GDP would show the cost to society. Such damage assessment and resource valuation can also be done at the local level to guide local leaders and managers in reversing the course in their jurisdictions, improving the health of their marine ecosystems, and designing infrastructure and development projects that would be more environmentally sound.

It is necessary that the entire range of factors – environmental, economic, social, and political – that may have an impact on the coastal and marine environment be considered when strategies for economic development are being drawn up so tradeoffs and synergies can be put in proper perspective. Policymakers and managers require such information to make strategic decisions about where to prioritize efforts, including for ecosystem protection, resource conservation, pollution reduction, and climate resilience, and monitor progress towards objectives and long-term sustainable development goals.

Third, and most importantly, **concrete actions** that reduce habitat destruction and pollution significantly, restore water quality, protect ecosystems and biodiversity, and reduce GHG emissions must be done now and at scale. Various technologies, nature-based solutions, financing

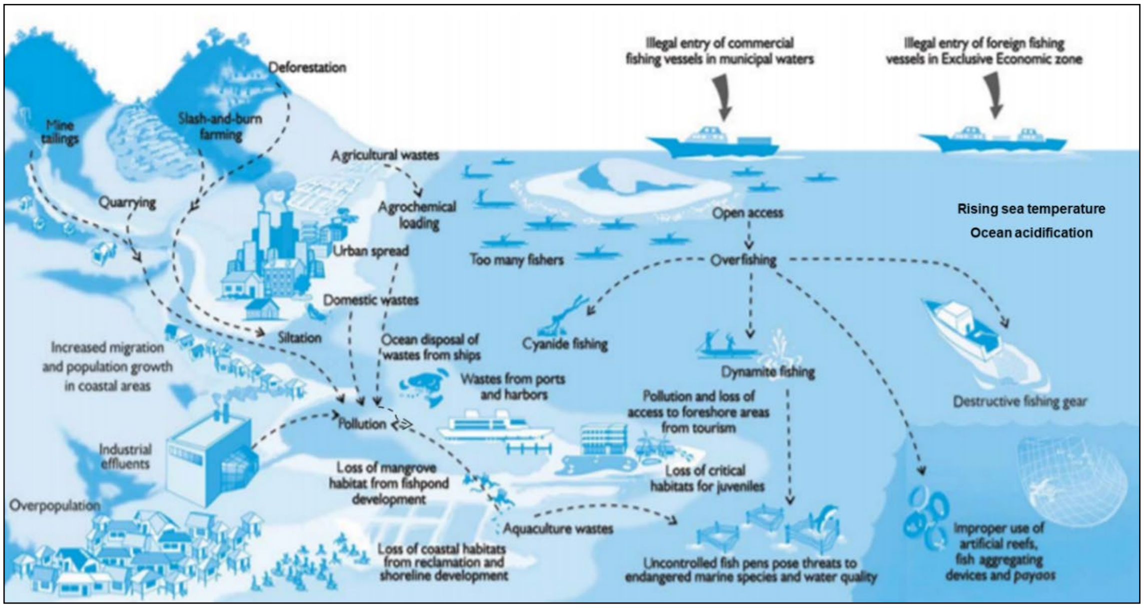
163 Halpern, et al. (2015) have calculated and mapped changes over five years in cumulative impacts to marine ecosystems globally from fishing, climate change, and ocean- and land-based stressors.

sources, and traditional and innovative instruments are available, but capacity, access to such technologies and financing, behavior change, and political support remain a challenge. SDG 12 identifies decoupling economic growth from resource use as one of the most critical and complex challenges facing humanity today. The effective decoupling require policies that create a conducive environment for such change, social and physical infrastructure and markets, and a profound transformation of business practices along global value chains.[164]

The deterioration of ocean health is a direct threat to the security, lives and livelihoods of the people in the region. The ecosystem services stand to be lost if measures are not undertaken for their conservation and sustainable use. Poorer households face disproportionate losses from the depletion of natural capital due to their relatively high dependence on certain ecosystem services for food, income, and insurance against hard times and changing climate. It has been estimated that ecosystem services and other non-marketed goods account for between 47 percent and 89 percent of the so-called 'GDP of the poor' (i.e., the effective GDP of total source of livelihood), whereas in national GDP, agriculture, forestry, and fisheries account for only 6-17 percent.[165]

There can be no sustainable and resilient future without a healthy ocean. Our existence depends on flows of goods and services delivered by a stock of natural resources – our 'natural' capital. However, we have degraded the planet's ecosystems and lost huge stocks of this natural capital. Just as economic systems collapse without reinvestment, so will ecological systems if they are allowed to continue to depreciate and be exploited without giving them time to renew or recover.

Figure 11.1: The Ocean Under Stress.



Source: DENR (modified).

164 UN Centre for Regional Development, 2020.
165 TEEB, 2010.

11.2 Measuring Ocean Health

A healthy ocean sustainably delivers a range of benefits to people now and in the future. The Ocean Health Index (OHI) defines a set of goals for ocean health, which means identifying the environmental, social, and economic benefits and services that healthy oceans provide to people. OHI is a decision-making tool and framework for conserving the human-ocean ecosystem because people need a healthy ocean.[166]

The vast majority of policy documents from around the world clearly define a healthy ocean as one that has both nature and people thriving.[167] The OHI is a useful assessment tool that scientifically measures key elements from all dimensions of the ocean's health — biological, physical, economic, and social. It provides a framework to evaluate sustainable delivery of benefits that people want from healthy oceans by measuring progress toward 10 widely-held societal goals:

(1) **food provision:** This goal measures the amount of seafood captured or raised in a sustainable way. Food Provision is divided into two subgoals: **(a) Wild-caught commercial seafood, and (b) Mariculture or ocean-farmed seafood**.

(2) **artisanal fishing opportunities:** This goal measures whether people who need to fish on a small, local scale have the opportunity to do so. The reference point for Artisanal Fishing Opportunities is that all demand for artisanal fishing is allowed and/or achieved and that the fishing is done in a way that does not compromise future fishing resources.

(3) **natural products:** This goal measures how sustainably people harvest non-food products from the sea.

(4) **carbon storage:** This goal measures the extent and condition of the natural coastal ecosystems - seagrasses, tidal marshes and mangroves - that store large amounts of carbon in their roots, stems and leaves and sequester it for decades or centuries in the sediment. The reference point for Carbon Storage compares the current extent and condition of CO_2 storing coastal habitats (mangrove forests, seagrass meadows, and salt marshes) relative to their condition in the early 1980s.

(5) **coastal protection:** This goal measures the condition and extent of five ecological habitats that protect the coasts against storm waves and flooding. Habitats assessed are mangrove forests, seagrass meadows, salt marshes, tropical coral reefs, and sea ice. The reference point for Coastal Protection compares the current extent and condition of protective habitats to their condition and extent in the early 1980s. The reference point for sea ice is its average extent during the period 1979-2000.

(6) **tourism and recreation:** This goal measures the proportion of the total labor force engaged in the coastal tourism and travel sector, factoring in unemployment and sustainability. The

[166] https://www.conservation.org/projects/ocean-health-index.
[167] Halpern, *et al*., 2015.

Tourism & Recreation goal aims to capture the experience people have visiting coastal and marine areas and attractions.

(7) **coastal livelihoods and economies:** People rely on the ocean to provide livelihoods (i.e., jobs with steady wages) and stable economies for coastal communities worldwide. The jobs and revenue produced from marine-related industries directly benefit those who are employed, but also have substantial indirect value for community identity, tax revenue, and other related economic and social aspects of a stable coastal economy. **(a) Livelihoods** sub-goal is a combination of jobs and wages. **(b)** The reference point for the **Economies** sub-goal is that a country's marine-related revenue must have no net loss and must keep pace with growth in GDP (or sustain losses no greater than the national decline in GDP).

(8) **sense of place:** This goal contains two subgoals. People derive a sense of identity or value from living near the ocean, visiting coastal or marine locations or just knowing that such places and their characteristic species exist. This goal tries to capture the aspects of the coastal and marine system that people value as part of their cultural identity by measuring two subgoals. **(a) Iconic Species** measures the condition of culturally important species; and **(b) Lasting Special Places** measures the percentage of area that is protected within a band from 3 nautical miles offshore to 1 km inland.

(9) **clean waters:** This goal measures contamination by chemicals, excessive nutrients (eutrophication), human pathogens and trash.

(10) **biodiversity:** This goal estimates how successfully the richness and variety of marine life is being maintained around the world. This goal contains two subgoals. Species evaluates the conservation status of marine species; Habitats evaluates the condition of key habitats that support high numbers of species.

The OHI also reflects the impacts of human activities, interventions, and changes in the state of the ocean on the benefits and values. The target is to get a score of **100**. Target setting makes clearer if management actions are enabling progress toward a sustainable use of ocean benefits.

The 2019 OHI global score for the exclusive economic zones (EEZs) is **71** out of 100.[168] In the EAS region, RO Korea and the Philippines have OHI scores that are higher than the global score. **Table 11.1** shows the OHI scores and ranking of the EAS countries as well as the goals which got the highest and lowest scores.

Among the goals, coastal protection, got the highest scores in four countries, followed by biodiversity, and tourism and recreation, which both got highest scores in two countries. These three goals as well as coastal livelihood and economies, carbon storage, food provision, and artisanal fishing opportunities are the major benefits derived from healthy oceans based on the high scores they got in the EAS countries.

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[168] http://www.oceanhealthindex.org/region-scores/key-findings; https://oceanhealthindex.org/global-scores/data-download/

- *Coastal protection* got the highest scores in Japan, Malaysia, Timor-Leste, and Viet Nam, and second highest in Indonesia and the Philippines.
- *Biodiversity* is highest in RO Korea and Thailand and second highest in Cambodia, Malaysia, and Viet Nam.
- Cambodia and the Philippines obtained high scores for *tourism and recreation*.
- Another important goal is *coastal livelihoods and economies*. This goal has the highest score for China, and second highest in RO Korea and Thailand.
- The goal of *artisanal fishing opportunities* is highest in Singapore and second highest in RO Korea.
- *Carbon storage* got the second highest scores in Japan and Timor-Leste.

Table 11.1: Ocean Health Index for EAS Countries (2019).

Country	OHI		Highest		Lowest	
	Overall Score	Global Rank	Goal	Score	Goal	Score
Cambodia	60	176	Tourism and recreation	100	Food provision	11
			Biodiversity	89	Sense of place	52
					Clean waters	53
China	63	158	Coastal livelihoods and economies	97	Clean waters	35
			Food provision	85	Sense of place	39
Indonesia	65	137	Natural products	92	Food provision	34
			Coastal protection	88	Tourism and recreation	36
Japan	66	125	Coastal protection	100	Natural products	8
			Carbon storage	95		
Korea, RO	76	48	Biodiversity	96	Tourism and recreation	14
			Coastal livelihoods and economies	95	Clean waters	60
			Artisanal fishing opportunities	95		
Malaysia	65	143	Coastal protection	94	Food provision	25
			Biodiversity	87	Sense of place	37
Philippines	83	71	Tourism and recreation	100	Sense of place	49
			Coastal protection	92	Coastal livelihood and economies	45
Singapore	68	108	Artisanal fishing opportunities	100	Natural products	9
			Food provision	97	Sense of place	33
Thailand	66	130	Biodiversity	90	Food provision	17
			Coastal livelihoods and economies	86	Natural products	44
Timor-Leste	59	187	Coastal protection	87	Food provision	25
			Carbon storage	85	Coastal livelihood and economies	28
Viet Nam	56	199	Coastal protection	89	Food provision	9
			Biodiversity	87	Natural products	23

Source: Ocean Health Index (http://www.oceanhealthindex.org/region-scores).

12 Marine Water Quality and Pollution Management

"Modern society will find no solution to the ecological problem unless it takes a serious look at its lifestyle."
Pope John Paul II

SDG targets:

- **SDG 14:**
    - **Target 14.1:** Reduce marine pollution

Other related SDGs:

- **SDG 6:**
    - **Target 6.3**: By **2030**, improve water quality by reducing pollution, eliminating dumping, and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.
        - ◊ Indicator 6.3.1: Proportion of domestic and industrial wastewater flows safely treated.
        - ◊ Indicator 6.3.2: Proportion of bodies of water with good ambient water quality.
- **SDG 11:**
    - **Target 11.6**: By **2030**, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
        - ◊ Indicator 11.6.1: Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities.
- **SDG 12:**
    - **Target 12.4**: By **2020**, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
        - ◊ Indicator 12.4.1: Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement.
        - ◊ Indicator 12.4.2: (a) Hazardous waste generated per capita; and (b) proportion of hazardous waste treated, by type of treatment.
    - **Target 12.4**: By **2030**, substantially reduce waste generation through prevention, reduction, recycling and reuse.
        - ◊ Indicator 12.5.1: National recycling rate, tons of material recycled.

Economic development and rising living standards in the EAS region have led to poverty reduction, but also in increases in the quantity and complexity of generated waste, while agricultural intensification, industrial diversification, and the provision of expanded health-care facilities have added substantial quantities of agricultural and industrial hazardous waste and biomedical waste into the waste stream with potentially severe environmental and human health consequences. Waters contaminated by chemicals, eutrophication (excess nutrients primarily from fertilizers or sewage), harmful algal blooms, disease-causing pathogens, oil spills, plastics, and trash can negatively impact human health, livelihoods, and recreational opportunities, as well as the health of marine wildlife and ecosystems.

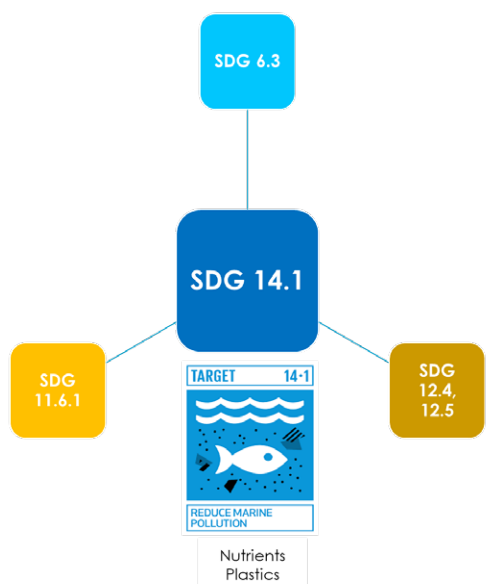
Approximately 70 percent of the region's human population lives in coastal areas, and rapid urbanization and industrialization, greater shipping traffic and fishing effort, intensive farming and aquaculture, as well as widespread deforestation, coastal habitat conversion, and nearshore development, are contributing towards the pollution problem. Pollutants, originating from both land and sea, are responsible for significant lethal and sub-lethal effects on marine life.

As SE Asia encompasses approximately a third of the world's coral reefs and mangroves, as well as the global biodiversity triangle, the need to reduce the impacts of marine pollution in this region becomes more critical. Except for Singapore, all the countries in ASEAN have major gaps related to emerging waste stream.

In the EAS region, targets from six SDGs (SDG 6, 11, 12, 13, 14 and 15) are relevant to reducing the inputs and impacts of various types of waste on terrestrial and marine ecosystems. SDG 14.1 calls for the reduction of marine pollution, especially nutrients and plastics.

Major sources of marine pollution include domestic and industrial wastes, sewage, agrochemical loading, siltation/sedimentation, toxic and hazardous wastes (including heavy metals and mine tailings), and oil spills.

Pollution in the marine environment can come from point and non-point sources. **Point sources** are materials that have a specific and identifiable discharge point in a water body. **Non-point sources**, on the other hand, have no identifiable sources and are usually associated with diffused entry through rainwater runoff from urban areas, and land-use practices, such as agriculture, and mining. Urban and agricultural run-off does damage to coral reefs and seagrass beds through pollution, sedimentation, and by blocking the sun's rays. Coral reefs and seagrass thrive in clean water because they need direct sunlight.



a. **Wastewater.** The main nutrients associated with biological productivity in marine systems are nitrates, phosphates, and silicates. As human populations increase, human-induced nutrient loading also increases, and these originate from point and non-point sources. Excessive amounts of nutrients can lead to more serious problems, such as algal blooms and low levels of oxygen dissolved in the water. This, in turn, can kill fish and other aquatic animals.

b. **Solid waste.** Solid waste disposal is a universal problem, especially in urban areas in China and Southeast Asia. Waste management is becoming an acute problem as the economies of these countries develop, urban population increases, and the quantities of waste materials requiring management increases. Litter is a prevalent eyesore in most populated areas and waterways, creating a serious problem for human health and the environment.

c. **Plastic waste.** The production, consumption and disposal of plastics pose serious threats to the EAS region's environment, human health, and the economy. EAS countries are at the front-line of these threats as major source and due to their geographic, environmental, and social characteristics. Plastic debris washed into the ocean through the rivers and drainage systems threaten marine life and the food chain.

   Marine debris. A source of great concern in the region includes land-based debris, and discards from both cargo and fishing vessels, which constitute a serious hazard to both biodiversity and transport. Marine debris poses a particular transboundary challenge – managing the impact from marine debris, plastic and microplastics without necessarily having control over the source. Discarded plastic items, such as fish aggregating devices used in the tuna industry, are a major hazard for sea turtles and seabirds. Entanglement of turtles and marine birds in discarded fishing nets, and death of turtles and birds caused by ingestion of plastic waste, is also an added factor.

Debris washed on the shores. *(Photo by TEI)*

12.1 Wastewater Situation

The deterioration of water quality is one of the most pressing environmental problems threatening human health, water resources, ecosystems, and sound economic development. Untreated wastewater poses a challenge that is particularly acute in the EAS region. Most countries in this region are in the midst of a structural shift that is straining its already limited infrastructure and capacity to effectively treat wastewater. According to the report by UN Water in 2017, in South and Southeast Asia, between roughly 60 and 80 percent of wastewater is still being discharged without treatment.

Targets on water environment were proposed under SDG 6 and emphasized not only the importance of on-site sanitation facilities but also the entire water cycle, including management of water, wastewater and biological resources. Achieving SDGs 6 and 14 means addressing the struggle of managing wastewater for safe discharge and reuse.

The present infrastructure in most of the countries in the region is facing an inability to accommodate the rapid increase of population in the urban and peri-urban areas. The urban centers are unable to serve their wastewater collection and treatment demand. Likewise, the coverage of wastewater management in the rural areas remains low. Many have severe problems with water services provision, sanitation, climate adaptation, and pollution, with untreated wastewater, solid waste, pesticides, plastics, and heavy metals being released into water supplies.

Several barriers across technology systems have been identified which show that offering either centralised, decentralised, or cluster technology systems as one solution is not enough to address changing future demands for wastewater treatment.[169] Corresponding to the technology options is the financing aspect – huge capital investment cost, and recurring operation and maintenance (O&M) costs – which influence community support and local government decision towards wastewater management system.

Sources of water pollution

There is a wide range of pollutants and pollution sources that potentially affect the coastal and marine environment. Studies have shown that around 80 percent of pollution comes from land-based sources. Pollution from these land-based sources, if not properly treated, finds its way through drains, rivers and finally to the sea. In terms of the biochemical oxygen demand (BOD) or chemical oxygen demand (COD), most of the pollution loadings come from domestic sources, except in China where agriculture is the biggest contributor (**Figure 12.1**).

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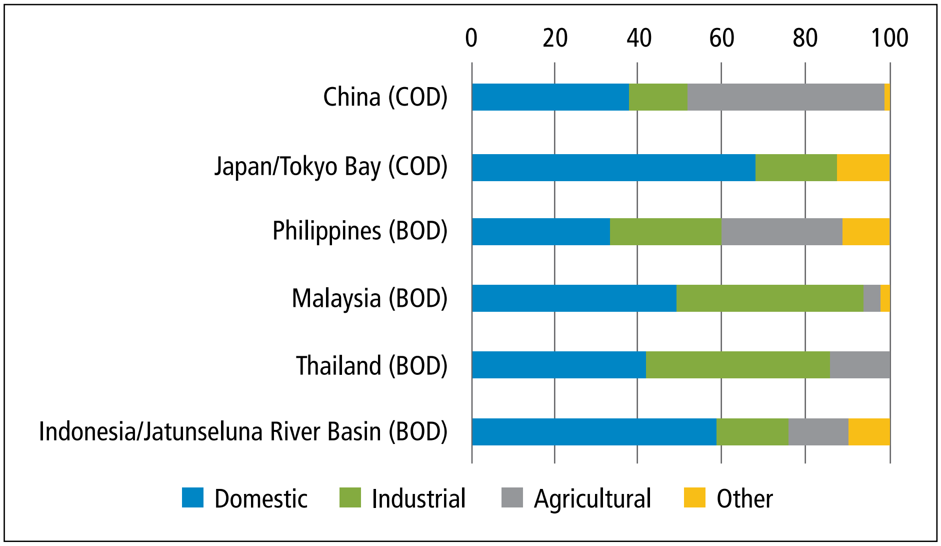
[169] Sotelo, *et al.*, 2019.

Figure 12.1: BOD/COD Loading From Different Sectors In Selected Countries.



Source: Suehisa, 2015 (WEPA).

Wastewater management: Policies, standards, monitoring, and treatment[170]

Environmental laws

Most EAS countries have set out a basic environmental law stipulating the protection of the environment and human health. The countries in the region have also adopted laws to protect the water resources, and control water pollution. Examples include Sub-Decree on Water Pollution Control (Cambodia), Water Pollution Control Law (Japan), and Clean Water Act (the Philippines).

Countries have legislations in place to prevent or mitigate pollution from untreated or partially treated industrial wastewater. For enforcement of existing legislations, various measures including onsite inspection provision, governmental guidance, and violation penalties have been introduced to ensure that industrial effluent quality complies with effluent standards. Inspections and penalties play an important role in addressing non-compliance. The NSOC Reports present the water quality in marine/coastal waters in countries with marine water quality monitoring system.

[170] Information in this section comes from the Ministry of Environment (Japan)-IGES 2019 report, and the NSOC reports.

Ambient water quality guidelines and monitoring

Ambient water quality standards are the administrative targets dictating the levels of water quality that need to be maintained. The countries in the EAS region have water quality standards, criteria and guidelines for marine water, surface water, and groundwater (**Table 12.1**).

Marine and estuarine water quality represents significant environmental issues within countries across the ASEAN region. ASEAN developed the *ASEAN Marine Water Quality Criteria* (AMWQC) and *ASEAN Long-Term Goals*, which can be used to benchmark coastal and inland water quality in the member countries.

National or local government agencies conduct ambient water quality monitoring in public water bodies – rivers, lakes and reservoirs, coastal and marine waters, and groundwater. **Table 12.2** shows the number of monitoring stations in each country.

In Japan, Philippines, RO Korea, Thailand and Viet Nam, water quality is evaluated based on criteria set by law and classes or intended uses of the water body. The results of water quality monitoring are compared to the criteria corresponding to the class of the water body, and the governments determine whether the water body satisfies the Water Quality Standard or not.

In China, river sections are categorised into six classes (I, II, III, IV, V, and worse than V) based on the classification stipulated in its Environmental Quality Standard. Water bodies are classified based on the results of water quality monitoring and classification in the Environmental Quality Standard.

Malaysia and Thailand use the Water Quality Index (WQI), and the same evaluation methodology concept as China. In Thailand, the coastal waters are monitored for eight parameters, and the values of the Marine WQI range between 0 and 100, where a score of 0-25 is considered very poor; 25-50 is poor; 50-80 is fair; 80-90 is good; and 90-100 is excellent.

Higashinada Wastewater Treatment Plant in Kobe, Japan. Biogas from this WWTP fuels vehicles. *(Photo by Japan Sanitation Consortium)*

Table 12.1: Ambient Water Quality Standards in EAS Region.

Country	Marine Water	Surface Water	Groundwater
Cambodia	Water Quality Standards in Public Water Areas	Water Quality Standards in Public Water Areas	Water Quality Standards in Public Water Areas
China	Sea Water Quality Standards	Environmental Quality Standards for Surface Water	Environmental Quality Standards for Groundwater
Indonesia	Standards Quality of Seawater	Water Quality Criteria	Water Quality Criteria
Japan	Environmental Quality Standards for Water Pollution	Environmental Quality Standards for Water Pollution	Environmental Quality Standards of Groundwater
Lao PDR		Surface Water Quality Standard	Groundwater Water Quality Standard
Malaysia	Marine Water Quality Criteria and Standard	National Water Quality Standards	
Philippines	Water Quality Criteria for Coastal and Marine Water (By classification of water body)	Water Quality Criteria for Surface Freshwater (By classification of water body)	Dinking Water Quality Standards
RO Korea	Environmental Standards for Water Quality and Aquatic Ecosystem	Environmental Standards for Water Quality and Aquatic Ecosystem	Environmental Standards for Water Quality and Aquatic Ecosystem
Singapore	Water Quality Guidelines	Water Quality Guidelines	
Thailand	Marine Water Quality Standard	Surface Water Quality Standard	Groundwater Quality Standard
Timor-Leste			
Viet Nam	National Technical Regulation on Coastal Water Quality	National Technical Regulation on Surface Water Quality	National Technical Regulation on Groundwater Quality

Source: Suehisa 2015 (WEPA); Ministry of the Environment (Japan)-IGES, 2019.

Table 12.2: Implementation of Ambient Water Quality Monitoring.

Country	Number of Monitoring Stations*				Frequency**
	Rivers	Lakes and Reservoirs	Marine	Groundwater	
Cambodia	10	2			Monthly
China	2424	343 4 (Three Gorges Dam)	147,940 km^2 (Spring) 135,420 km^2 (Summer)	6,124	Unknown
Indonesia	598				At least twice a month
Japan	3,924[a] 4,578[b] 1,783[c]	401[a] 477[b] 168[c]	1,060[a] 2,054[b] 293[c]	3,196[d] 818[e] 4313[f]	Monthly
RO Korea	1745	191		3353	Monthly for rivers and lakes; 48 times/year for key locations; Twice per year for groundwater
Malaysia	904	90	151 (coastal) 76 (estuary)	105	Unknown

Table 12.2: Implementation of Ambient Water Quality Monitoring. (cont.)

Country	Number of Monitoring Stations[*]				Frequency[**]
	Rivers	Lakes and Reservoirs	Marine	Groundwater	
Philippines	192	42	351[***]	88[**] 1,029[****]	Monthly (rivers and lakes) Unknown (groundwater)
Thailand	600	35	221	620	4 times/year (rivers and lakes) 2 times/year (marine water)
Viet Nam	522		145		4 times/year

Notes:
[a] indicators for human health protection
[b] indicators for living environment
[c] indicators for aquatic biodiversity
[d] summary survey
[e] survey of are surrounding polluted wells
[f] continued surveillance (a-c 2016; d-f 2017)
Sources: [*] MOE (Japan)-IGES 2019; [**] Suehisa 2015 (WEPA); [***] DENR-EMB 2017 (coastal recreational waters); [****] Kho and Saño, 2006.

Effluent water quality standards and monitoring

Monitoring of effluent quality is necessary to check the levels of compliance with standards. Countries in the EAS region have set industrial effluent standards. Standards for effluent discharge vary from country to country. Despite obligations on owners or managers of pollution sources and wastewater treatment facilities to monitor effluent quality, this is not comprehensively carried out in all countries.

China, Lao PDR, Thailand, and Viet Nam based their standards on the type of industry.

Cambodia's industrial effluent standards were set up according to proximity of pollution sources to sensitive environmental or ecosystem conservation areas. The central government in Cambodia conducts monitoring at sites suspected of discharging high concentrations of effluent.

The Philippines has a set of criteria for different parameters corresponding to the classification or use of the water body. Pollution loading (biochemical oxygen demand or BOD) contributed by the industrial and commercial establishments with or without discharge permit were monitored to determine the percent loading that is treated.

Japan and RO Korea introduced the total pollution load control (TPLC) system in specific water bodies in addition to effluent control via pollutant concentration. RO Korea also has a Coastal Total Pollutant Load Control System.

In Japan, recording of monitoring results became mandatory under a revision to the Water Pollution Control Law in 2010. In RO Korea, the centralised monitoring of effluent using telemetering was introduced for pollution sources (industries and domestic wastewater treatment facilities) exceeding certain volumes.

Indonesia and Thailand are introducing the total maximum daily load (TMDL) system.

Malaysia introduced an online reporting system for industry to self-report effluent monitoring results through a website.

Incentives for industries

Countries in the region have attempted to encourage industries to comply with regulation using alternative measures.

Indonesia is implementing the *Program for Pollution Control Evaluation and Rating* (PROPER) to encourage industries to comply with environmental regulations by publishing their environmental performance, including whether they meet designated effluent qualities or not. (*See **Section 12.5.7** for more details about this program.*)

Japan has introduced provisional effluent standards for specific types of industries that face difficulties in complying with original effluent quality standards in order to encourage technical improvements to be made within a specified a time limit.

Malaysia also has introduced lax policy that exempts industries from the immediate need for compliance with effluent standards if treatment facilities are under construction or being upgraded.

Wastewater treatment

There are several barriers to wastewater management (**Table 12.3**), but solution options are available, ranging from on-site treatment facilities and decentralized systems, to centralized and cluster wastewater treatment systems — with a variety of technologies to choose from.

Most of the countries in Southeast Asia do not have sewerage systems and rely on septic tanks: 88 percent of households in urban areas of Viet Nam; 83 percent for Thailand; 72 percent for the Philippines; 58 percent for Lao PDR; 63 percent for Indonesia, and 44 percent for Cambodia.[171] However, there is a lack of policies on the appropriate design, construction, and operation and maintenance of septic tanks, desludging, and septage treatment. For instance, 75 percent of septic tanks in Viet Nam and 66 percent in Indonesia have never been desludged or emptied.[172]

[171] MOE (Japan)-IGES, 2019.
[172] World Bank, 2015.

Table 12.3: Barriers to Wastewater Management in Southeast Asia.

Barriers	Challenges	Current Solutions
Economic	• Capital cost of investment in wastewater management infrastructure • Additional operation and maintenance cost of installed infrastructure	• Government or private funding to provide initial capital investment • *Public-private partnerships arrangements* • *Tariffs and user fees for wastewater management services for cost recovery*
Community	• Understanding of need for wastewater management through establishing the need for sanitation infrastructure • Lack of knowledge of pollution source *and cost of impacts of lack of sanitation and wastewater management* • Resistance to practice maintenance of sanitation and wastewater management infrastructure	• Community-led Total Sanitation is used to create the need for sanitation • *Public awareness campaign on sanitation and wastewater impacts, benefits of treatment and reuse, and available solution options*
Institutional	• Mistranslation of national level policies to different localities and implementing institutions • Decentralized maintenance management of wastewater treatment facilities • Lack of discussion of needs and wants between institutions and localities/ households and communities	• Creation of national-level policies for environmental protection, including sanitation and wastewater management • Participatory engagement of stakeholders with local wastewater management institutions • *Capacity building on development of appropriate and cost-effective facilities, cost recovery, and management*
Technical	• Poor maintenance of existing infrastructure • Absence of wastewater management infrastructure • Piecemeal introduction of infrastructure	• Desludging of septic tanks by wastewater management institutions/utilities • Introduction of low-maintenance decentralized wastewater treatment system, and cluster wastewater technology systems • Construction and operation of centralized wastewater treatment systems • *Possible waste-to-energy and reuse of treated wastewater and sludge*

Source: Modified from Sotelo, et al., 2019. Additional items in italics.

12.2 Solid Waste

Solid waste can be defined as: **the useless and unwanted products in the solid state derived from the activities of and discarded by society**. It is produced either by product of production processes or arise from the domestic or commercial sector when objects or materials are discarded after use.

Solid waste can be classified into different types depending on their source:

(a) Household waste is generally classified as municipal waste,
(b) Industrial waste as hazardous waste,
(c) Biomedical waste or hospital waste as infectious waste

Municipal solid waste

Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes.

With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. Household waste can also be classified in several ways, but the following list represents a typical classification:

- **Biodegradable waste:** food and kitchen waste, green waste, paper (most can be recycled, although some are difficult to compost, plant material may be excluded)
- **Recyclable materials:** paper, cardboard, glass, bottles, jars, tin cans, aluminum cans, aluminum foil, metals, certain plastics, textiles, clothing, tires, batteries, etc.
- **Inert waste:** construction and demolition waste, dirt, rocks, debris
- **Waste electrical and electronic equipment (WEEE)**: electrical appliances, light bulbs, washing machines, TVs, computers, screens, mobile phones, alarm clocks, watches, etc.
- **Composite wastes:** waste clothing, Tetra Pack food and drink cartons, waste plastics, such as toys and plastic garden furniture
- **Hazardous waste:** most paints, chemicals, tires, batteries, light bulbs, electrical appliances, fluorescent lamps, aerosol spray cans, and fertilizers
- **Toxic waste** including pesticides, herbicides, and fungicides
- **Biomedical waste:** syringes, expired pharmaceutical drugs, etc.

Proper and regular waste collection is a key issue. The environmental and health impacts of such operations are potentially significant, and the lack of comprehensive solid waste management system (waste segregation, waste reduction, regular collection, reuse/recycling, disposal into sanitary landfills, closure of open dumpsites, and monitoring of the impacts on the surrounding communities, land, water resources, coastal waters and habitats) is becoming a matter of concern.

Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminum foils, plastics, and other nonbiodegradable items that can cause harm to the environment if not properly collected and treated. **Table 12.4** shows the time it takes for different types of waste to degenerate.

Certain biodegradable items can be composted and reused while other items are recyclable. The proper handling of the biodegradable and recyclable waste will considerably lessen the burden of solid waste that each town or city has to properly disposed of, and prolong the lifespan of sanitary landfills.

Table 12.4: Types of Litter and Time it Takes to Degenerate.

Type Of Litter	Approximate Time
Organic waste, such as vegetable and fruit peels, leftover foodstuff, etc.	1-2 weeks
Paper	10-30 days
Cotton cloth	2-5 months
Wood	10-15 years
Woolen items	1 year
Tin, aluminum, and other metal items like cans	100-500 years
Plastic bags	1 million years?
Glass bottles	undetermined

Hazardous waste

Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things, e.g., gases.

Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.

Hospital waste contaminated by chemicals used in hospitals is considered hazardous. These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure.

In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.

Direct exposure to chemicals in hazardous waste, such as mercury and cyanide, can be fatal.

Hospital waste

Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biologicals. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner.

Table 12.5: Amount of Waste Generation in ASEAN.

No.	Countries	Waste Generation			
		Per Capita MSW Generation (kg/capita/day)	Annual MSW Generation (in ton)	Annual Hazardous Waste Generation (in MT)	Annual E-waste Generation (in Metric Kiloton ton)
1	Brunei Darussalam	1.4	210,480		
2	Cambodia	0.55	1,089,429		
3	Indonesia	0.70	64,000,000		
4	Lao PDR	0.69	77,380		8.00
5	Malaysia	1.17	12,840,000	1,517,434.06	
6	Myanmar	0.53	841,508		
7	Philippines	0.69	14,660,000	1,693,856.75	39,000
8	Singapore	3.763	7,514,500	411,180	110
9	Thailand	1.05	26,770,000	3,300,000	368.314
10	Viet Nam	0.84	22,020,000		1,609.775

Source: UNEP, 2017.

12.2.1 Municipal Solid Waste[173]

Indonesia is generating the highest quantity of municipal waste with 64 million tonnes per year, followed by Thailand (26.77 million tonnes), Viet Nam (22 million tonnes), while Lao PDR is generating the lowest quantity of municipal solid waste (77380 tonnes). On per capita basis, Singapore is the highest MSW generator, followed by Brunei and Malaysia (**Table 12.5**).

The MSW generated in the ASEAN countries is composed mainly of organic waste, plastic, paper, glass and metal (**Table 12.6**). Organic waste constitutes a bulk of MSW in ASEAN countries, except for Singapore, offering opportunity for waste reduction, while plastic, paper, glass, and metal offer opportunities for recycling. Approximately 25 percent of the waste is non-biodegradable and, thus, poses a serious long-term threat.

According to the UNEP (2017) report:

- Cambodia: 60% of the MSW is organic waste, followed by plastic (15%), paper (9%) and glass (3%);
- Indonesia: 60% of the MSW is organic waste, followed by plastic (14%) and paper (9%).
- Lao PDR: 64% of the MSW is organic waste, followed by plastic (12%) and paper (7%);
- Malaysia: 45% of the MSW is organic waste, followed by plastic (13.2%) and paper (8.2%);
- Myanmar: 73% of the MSW is organic waste, followed by plastic (17.75%) and paper (2.24%);

[173] Information in this section is from: UNEP, 2017.

- Philippines: 52% of the MSW is organic waste, followed by plastic (10.55%) and paper (8.70%).
- Singapore: 10.5% of the MSW is organic waste, followed by metal (20.8%), construction debris (16.9%) and plastic (16.5%).
- Thailand: 64% of the MSW is organic waste, followed by plastic (17.62%) and paper (8%).
- Viet Nam: 55% of the MSW generated in the country is organic waste, followed by plastic (10%), paper (5%) and metal (5%).

Countries across ASEAN have already passed national legislation and established national strategies to address challenges related to waste and environmental management. These get addressed broadly in their policy and regulatory framework and strategies like green growth, environmental protection, sustainable development, and climate change. However, implementation of laws and plans remains a challenge. There is inadequate system for the regular collection of municipal waste, waste segregation, reuse and recycling, and proper disposal of residual waste. Low-value and non-recyclables (e.g., films, sachets, and composites) are mostly disposed of and collected together with other residual wastes. There is no systematic separation and recycling of the low-value recyclables. The participation of informal sector for all the waste streams and in collection and segregation of waste make it challenging to obtain information on their coverage and efficiency. Some landfills are poorly located near waterways. Some garbage collectors dump collected waste into rivers, mangroves, or vacant areas to save costs (e.g., fuel, tipping fees of landfills, etc.).

Table 12.6: Amount and Composition of MSW in ASEAN.

No.	Countries	MSW Composition (%)									
		Food/ Organic Waste	Paper	Plastic	Metal	Glass	Textile	Rubber	Grass/ Wood etc. waste	Construction Debris	Other
1	Brunei Darussalam	36	18	16	4	3					
2	Cambodia	60	9	15		3	1	1			
3	Indonesia	60	9	14	4.3	1.7	3.5	5.5			2.4
4	Lao PDR	64	7	12	1	7	5	3			
5	Malaysia	45	8.2	13.2	3.3						27.3
6	Myanmar	73	2.24	17.75		0.45	1.14				5.15
7	Philippines	52	8.70	10.55	4.22	2.34	1.61				
8	Singapore	10.5	16.5	11.6	20.8	1.1	2.1		8.6	16.9	11.9
9	Thailand	64	8	17.62	2	3	1.4	1	1		
10	Viet Nam	55	5	10	5	3		4			

Source: UNEP, 2017.

12.2.2 Plastic Waste

Plastic is a synthetic organic polymer made from petroleum with properties ideally suited for a wide variety of applications, such as packaging, building and construction, household and sports equipment, and parts of vehicles, electronics and appliances.

Plastic pollution in oceans and rivers is an emerging environmental hazard, and accumulation on riverbanks, deltas, coastlines, and oceans is rapidly increasing. Plastic wastes pose threats on aquatic life, ecosystems, food safety and quality, and human health, and contributes to climate change.

According to a UNEP[174]: Plastic waste is now so ubiquitous in the natural environment that scientists have even suggested it could serve as a geological indicator of the Anthropocene era. In the early 2000s, output of plastic waste rose more in a single decade than it had in the previous 40 years. Globally, 300 tonnes of plastic waste are produced every year. About 60 percent of that plastic has ended up in either a landfill or the natural environment. More than 99 percent of plastics are produced from chemicals derived from oil, natural gas and coal — all of which are dirty, non-renewable resources. If current trends continue, by 2050 the plastic industry could account for 20 percent of the world's total oil consumption.

There was also a shift away from the production of durable plastic, and towards plastics that are meant to be thrown away after a single use. A staggering 91 percent of all plastic is single-use, and this has resulted in more than 8.3 billion tonnes of plastic waste produced since the early 1950s.[175]

Land-based plastics are one of the main sources of marine plastic pollution, by direct discharges from the coastal areas or by transport through rivers, from urban and storm runoff, sewer overflows, industrial activities, construction, littering, and illegal dumping.

In addition to the land-based pollution, illegal dumping in the seas is also a significant contributor to pollution in the region's seas. Ocean-based plastic originates mainly from the fishing industry, nautical activities, and aquaculture. One of the most damaging forms of plastic found in the ocean is **ghost gear**—fishing nets abandoned at sea. Ghost gear constitutes **10 percent** of marine litter and wreaks havoc on natural ecosystems by blocking sunlight and entangling wildlife.[176]

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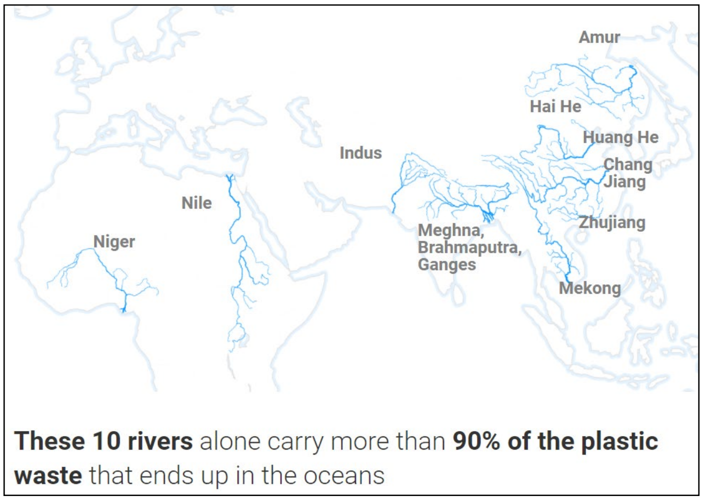
174 UNEP (https://www.unep.org/interactive/beat-plastic-pollution/)
175 Geyer, Jambeck and Law, 2017.
176 https://asia.nikkei.com/Spotlight/The-Big-Story/Asian-plastic-is-choking-the-world-s-oceans

More than 80 percent of marine plastic pollution comes from Asia.[177] Around 10 to 18 percent of MSW in the EAS region is plastic waste (**Table 12.7**). The lack of integrated solid waste management system – poor garbage collection, no waste segregation, inadequate facilities for recycling, and lack of sanitary landfills – results in wastes ending up in waterways and coasts.

Figure 12.2: Plastic Waste Carried by Rivers to the Ocean.



Source: UNEP (https://www.unep.org/interactive/beat-plastic-pollution/)

What are the impacts of plastic pollution?

Plastic pollution causes severe economic losses through damage to vessels and fishing gear, negative effects on the tourism industry, and increased shoreline cleaning efforts, adding up to US$1.26 billion per year for the Asian-Pacific Rim alone.[178]

The most visible and disturbing impacts of marine plastics are the ingestion, entanglement, and suffocation of marine species. Seabirds, whales, fishes, turtles, and other marine animals mistake plastic waste for prey and food, and their stomachs are filled with plastic debris. They also suffer from lacerations, infections, and internal injuries.

When marine organisms ingest plastic debris, these contaminants enter their digestive systems, and overtime accumulate in the food web. The transfer of plastic contaminants between marine species and humans through consumption of seafood has been identified as a health hazard, but has not yet been adequately researched. Plastic has also been found in tap water as existing water treatment facilities are not able to filter out microplastics and nanoplastics.

These are all staggering statistics. It is clear that we are in the midst of a global plastic crisis.

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177 Ocean Conservancy, 2017.
178 McIlgorm *et al.*, 2011; Meijer *et al.*, 2021.

What can be done?

Plastic pollution can be broadly addressed under an overarching framework of Agenda 2030 and the SDGs. In the EAS region, thirteen targets from five SDGs (SDG 6, 11, 12, 14 and 15) are relevant to the reduction of the inputs and impacts of plastic wastes on terrestrial and marine ecosystems. Other SDG targets, which encompass the promotion of alternatives to the use of conventional plastic as well as social and economic resilience include SDG 1 (1.4), SDG 8 (8.3), SDG 9 (9.3 and 9.4). These additional three SDGs cover poverty, sustained, inclusive and sustainable economic growth and employment, resilient infrastructure and inclusive and sustainable industrialization.

Other multilateral environmental agreements (MEAs) are the 1972 Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (or the London Convention), the 1996 Protocol to the London Convention (the London Protocol), and the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships (MARPOL). Meanwhile, there is a need to have corresponding national laws, national ocean governance structure, capacity, knowledge, financing resources, public awareness and international cooperation to improve compliance with and enforcement of these international agreements.

Plastic use reduction, recycling and reuse of plastic materials are the most effective actions available to reduce the environmental impacts of open landfills and open-air burning that are often practiced in managing municipal waste. Plastic is a petroleum product, and if it is incinerated, it releases CO_2 into the atmosphere, thereby increasing carbon emissions.

The removal of plastics from the production and use cycle can be achieved by minimizing the availability of single-use plastic products, especially if appropriate alternatives are available. For instance, refrain from using plastic straws and disposable cutlery, plates, and cups, and provide drinking water dispensers so that individuals can re-fill containers rather than rely on single-use plastic bottles. The ban of plastic bags in stores and groceries also encourage people to bring their own reusable bags.

Japan and Singapore mandated the producers of packaging and packaged products to collect data on the types and amounts of packaging they place in the market each year and report the packaging data to either a relevant industry-led producer responsibility organization or to the government as the first step towards more sustainable packaging waste management. This reporting lays the foundation of an Extended Producer Responsibility (EPR) framework for managing packaging waste and also gives an accurate estimate of the amount of plastic in final products that are imported.

Creating a ‘circular economy’ which works effectively, and is accepted by business and the public, requires many intermediate stages, including introducing appropriate infrastructure and investment, and facilitating behavioral change throughout the supply chain. The goal of a circular economy is to severely restrict both the use of new raw materials, production of residual waste, and reduce overall consumption.

However, current technology for plastic production is not sufficiently connected with recycling (World Economic Forum 2016). In addition, the circular model in its present state is inadequate as it does not extend to monitoring or capturing single-use materials that leak out of the circular loop or have already escaped into the environment.[179]

It is important to assess where recycling can be done. There are benefits to be gained from recycling. For example, the Philippines recycled only 28 percent of key plastic resins in 2019, resulting in lost material value upwards of US$ 890 million per year.[180]

Nevertheless, solution options should go beyond the reduction of plastic use, recycling and reuse. It is crucial to consider the whole lifecycle of plastic products, from product design to infrastructure and household use, and find or shift towards plastic alternatives. Hence, support for research and innovation, international collaboration, and trade policy reforms are essential to accelerate new technologies, materials and products to replace single-use plastics.

12.2.3 E-waste

The use of electrical appliances and electronic gadgets is still on the rise, given their importance in professional and personal activities daily. These devices, typically powered by a battery or a power supply, are used in all parts of the world and across all strata of society. This section on e-waste is based on the UN University (UNU) report by Shunichi Honda, D. S. Khetriwal and R. Kuehr (2016).

In 2012, an estimated 56.56 million tonnes of Electrical and Electronic Equipment (EEE) were put on the global market. Asia is both the world's largest manufacturer of and market for EEE, consuming 26.69 million tonnes in 2012 of what was put on the global market, or about half the global amount.

In 2014, Asia generated 16 million tonnes of e-waste, which equals 3.7 kg per inhabitant compared to 15.6 kg per inhabitant in Europe. As Asian countries rapidly industrialise, and their citizens enjoy higher income and living standards, the consumption and disposal of EEE will continue to increase.

Properly handling end-of-life products is not only an environmental benefit, but it also protects the public's health, which is negatively impacted by improper recycling practices that emit hazardous substances. Proper handling also preserves limited resources essential for the production of high-tech products.

179 Carr, 2020.
180 World Bank, 2021o.

The volume of discarded electronics in East and Southeast Asia was 12.3 million tonnes in 2015. There was 63 percent increase in e-waste generation between 2010 and 2015, and it is growing fast in both total volume and per capita measures.[181]

China alone more than doubled its generation of e-waste between 2010 and 2015 to 6.7 million tonnes, up 107 percent.

The average e-waste generation per capita in the region was approximately 10 kg in 2015. There were large differences between nations on the per capita scales

- Lowest: Cambodia (1.10 kg), Viet Nam (1.34 kg), and the Philippines (1.35 kg)
- Highest: Hong Kong, SAR China (21.7 kg), and Singapore (19.95 kg).

Four main trends responsible for increasing volumes:

- **More gadgets:** Innovation in technology is driving the introduction of new products, particularly in the portable electronics category, such as mobile phones, tablets, and wearables like smart watches.
- **More consumers:** In the East and Southeast Asian region, there are growing populations, and rapidly expanding middle classes able to afford more gadgets.
- **Decreasing usage time:** The usage time of gadgets has decreased; this is not only due to rapidly advancing technology that make older products obsolete due to hardware incompatibility (e.g., flash drives replacing floppy disks) and software requirements (e.g., minimum requirements for personal computers to run operating software and other applications) but also soft factors, such as product fashion. E-waste grows as more devices are replaced more rapidly.
- **Imports:** Import of EEE provides greater availability of products, both new and second-hand, which also increases e-waste as they reach their end of life.

Issues

Improper and illegal e-waste dumping is prevalent in most countries in this study, irrespective of national e-waste legislation. Consumers, dismantlers, and recyclers are often guilty of illegal dumping, particularly of "open dumping", where non-functional parts and residues from dismantling and treatment operations are released into the environment.

Studies in the region show that the main reasons for the illegal dumping are:

- **Lack of awareness:** End users do not know that they should dispose of their obsolete EEE separately or how or where to dispose of their e-waste. Additionally, informal e-waste recyclers often lack the knowledge about the hazards of unsound practices.

[181] UN University 2016.

- **Lack of incentives:** Users choose to ignore collection and/or recycling systems if they need to pay for them.
- **Lack of convenience:** Even if disposal through existing systems does not incur a fee, users may choose not to dispose of their e-waste in the proper channels if it is inconvenient or requires their time and effort.
- **Absence of suitable sites:** There may be a lack of proper locations for hazardous waste disposal where residues from e-waste recycling can be sent.
- **Weak governance and lax enforcement:** A country with inadequate management or enforcement of e-waste legislation may result in rampant non-compliance.

The UNU report also points to common practices such as open burning, which can cause acute and chronic ill-effects on public health and the environment.

Open burning of e-waste is practiced mainly by informal recyclers when segregating organic and inorganic compounds (e.g., burning cables to recover copper).

Informal recycling, also called "backyard recycling", is a challenge for most developing countries in the region, with a large and burgeoning business of conducting unlicensed and often illegal recycling practices from the backyard.

These processes are not only hazardous for the recyclers, their communities, and the environment, but they are also inefficient, as they are unable to extract the full value of the processed products. Mostly, these recyclers recover gold, silver, palladium, and copper, largely from printed circuit boards (PCBs) and wires using hazardous wet chemical leaching processes, commonly also known as acid baths.

Typically, informal recyclers use solvents, such as sulphuric acid (for copper) or aqua regia (for gold). The leachate solutions go through separation and purification processes to concentrate the valuable metals and separate impurities. This often results in the release of toxic fumes.

"*Open burning and acid bath recycling in the informal sector have serious negative impacts on processers' occupational health*," Shunichi Honda co-author of the study warns. "*In the absence of protective materials, such as gloves, glasses, masks, etc., inhalation of and exposure to hazardous chemicals and substances directly affect workers' health.*" Adds co-author Deepali Sinha Khetriwal, Associate Programme Officer, UN University: "*Indirect exposure to these hazardous substances is also a cause of many health issues, particularly for families of informal recyclers who often live and work in the same location, as well as for communities living in and around the area of informal recycling sites. Associations have been reported between exposure from improper treatment* *of e-waste and altered thyroid function, reduced lung function, negative birth outcomes, reduced childhood growth, negative mental health outcomes, impaired cognitive development, cytotoxicity and genotoxicity."*

Response measures

According to the UNU report, Japan, RO Korea, and Taiwan (China) have a head start in the region in establishing e-waste collection and recycling systems, having begun in the late nineties to adopt and enforce e-waste specific legislation. This was built in large part on experience in solid waste management. Among the most advanced economies and areas in Asia, the three are also characterised by high per capita e-waste generation, formal collection and recycling infrastructure, and relatively strong enforcement.

Hong Kong SAR, China, and Singapore, meanwhile, do not have specific e-waste legislation. Instead, the governments collaborate with producers to manage e-waste through public-private partnership.

China, Philippines, Malaysia and Viet Nam all have e-waste legislation. These four countries are therefore in a transitionary phase, with a mix of formal and informal elements in an evolving ecosystem in terms of collection and recycling infrastructure. The countries face similar challenges in enforcing regulations with limited resources and capacity and low public awareness regarding the hazards of improper disposal of e-waste.

Cambodia, Indonesia and Thailand have yet to establish legal frameworks for e-waste management. Timor-Leste also raised the issue of its increasing e-waste pollution (in its NSOC Report). However, there is an active informal sector in these countries with an established network for collection and import of end-of-life products and their recycling, particularly repair, refurbishment and parts harvesting.

All the countries in the region control e-waste either via the Basel Convention or their national legal frameworks. However, measures to control the import of second-hand electronics vary among the countries. There are two types of measures to control the importation of e-waste and second-hand electronics:

(a) Control the import of e-waste but do not restrict second-hand electronics (Japan, Philippines, RO Korea, Singapore, Viet Nam).
(b) Prohibit the import of e-waste and prohibit or restrict the import of second-hand electronics (Cambodia, China including Hong Kong, Malaysia, and Viet Nam).

Despite these formal steps, enforcement of these measures remains a significant challenge in these countries.

12.3 Oil Spills

Pollution by oil has been recognized to be of increasing severity, requiring urgent concerted action on a regional basis. Oil spills can harm coastal and marine ecosystems, sea creatures, and wild birds, ruin a day at the beach, and make seafood unsafe to eat.

The issue of oil pollution merits special attention because some countries in the region are major producers of petroleum. Furthermore, the East Asian Seas are critical routes for oil tanker traffic between the Middle East and the northwest Pacific as well as for container ships. Thus, the probability of incidence of spillage from groundings or collisions is relatively high. An increased risk of oil spills necessitates an increase in the capability to prevent, respond and manage major oil spill incidents. The countries of the region recognized the need for:

- A scientific program involving research on oil and oil dispersant toxicity; effects of pollutants and other destructive factors on coral reefs, mangroves, mudflats and other coastal ecosystems and related fisheries; physical oceanographic processes affecting the pathways and fate of oil upon entering the sea; and oil spill modelling
- Implementation of a technical and scientific support program for oil spill contingency planning
- Coordinating mechanism for monitoring, preventing and controlling oil spills and overall marine pollution.

Most of the countries in the region have been successful in establishing the elements of preparedness advocated by the OPRC (International Convention on Oil Pollution Preparedness Response and Cooperation). Nevertheless, recent spill incidents and preparedness work in the region have revealed a need for greater collaboration between the governments and industry stakeholders from oil, shipping and port industries, contingency planning for major transboundary oil spill incidents, and alignment of oil spill preparedness and response system of a country from the national to local level, and among the countries. It takes sound science to clean up the oil, measure the environmental damages, and help the ocean recover.

Operational spills

Bilge dumping is the disposal of wastewater from a ship's lower hull. Bilge water is supposed to be treated before it is discharged, but sometimes vessel operators will bypass the pollution control equipment and flush oily, untreated bilge into the ocean – in direct violation of marine pollution law.

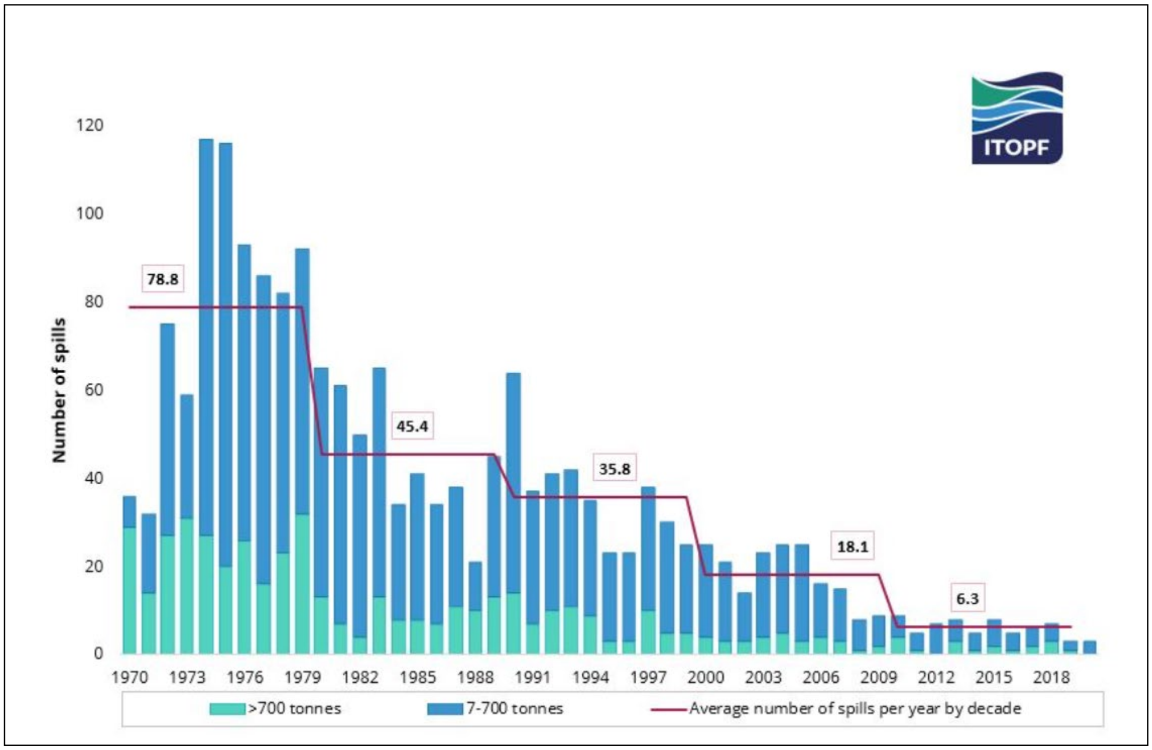
There are examples showing that bilge dumping continues to be a problem in the waters of Southeast Asia. Oil slicks in traffic-heavy locations like the Strait of Malacca are known to occur, but bilge dumps also happen elsewhere in Southeast Asia. With the use of new technologies and satellite imagery, anyone, anywhere can see what is happening on the water and help to raise the alarm. In satellite imagery, oily bilge dumps usually form distinctive linear slicks. By matching the time of the imagery to broadcasts from a vessel tracking service called automatic identification system (AIS), the identity of vessels that appear to be causing the slicks can be identified.

Accidental spills

Accidental oil spills are caused by shipping accidents (e.g., collision, engine breakdown, fire, explosion, sinking of ships, etc.), blowout of an offshore oil well, or breakage of pipelines.

ITOPF maintains a database of oil spills from tank vessels, including combined carriers, FPSOs and barges. The database contains information on accidental spillages of persistent and non-persistent hydrocarbon oil since 1970, except those resulting from acts of war. The information held includes the location and cause of the incident, the vessel involved, the type of oil spilt, and spill amount, and the spills are generally categorised by size: <7 tonnes, 7-700 tonnes, and >700 tonnes (<50 bbls, 50-5,000 bbls, >5,000 bbls). The statistics for the frequency of spills greater than 7 tonnes from tankers have shown a marked downward trend, as illustrated in **Figure 12.3**.

Figure 12.3: Global Oil Spill Trend (1970-2020).



Source: ITOPF, 2021.

12.4 Charting New Directions for Pollution Management

This section provides a few examples of policies, programs and good practices in the EAS region, providing us with doable solution options that can be replicated, scaled up, and improved upon.

12.4.1 Innovative Wastewater Treatment

The developing economies in the EAS region are hard-pressed in keeping up not only with the ever-increasing demand for clean water but also the provision of services to properly manage wastewater given its significant health, environmental and economic risks. For governments and water service providers alike, the task at hand presents the challenge of finding ways that increasingly require innovative technology and financing solutions.

With the unprecedented pace of technological advancement, operators now are given the flexibility to choose among a variety of technical solutions in dealing with wastewater management. Their choice would depend on the specific objectives the water operators would want to achieve, such as operational efficiency, regulatory compliance, cost efficiency, or resource recovery.

Singapore is often cited as a best practice case for urban water services. Its entire water cycle is managed by the municipally owned Public Utilities Board, including sewerage and drainage systems, allowing for more integrated water policymaking. Today, 100 percent of Singapore's population has access to drinking water and sanitation; all wastewater is collected and treated; and the entire water supply system, from water works to consumers, is metered. But this comes with a high price tag.

Limited financial resources demand environmental engineers to design environmentally and economically sustainable wastewater treatment systems. From an economic perspective in particular, the differentiation in centralized and decentralized systems is of relevance. Decentralized wastewater treatment systems offer a solution option for wastewater management in countries were expensive centralized systems are not cost effective.

Decentralized systems convey, treat, and dispose or reuse wastewater from small and low-density communities, buildings and dwellings in remote areas, and individual public or private properties.[182] These systems similarly treat wastewater close to the source, typically using small pipes for collecting small volumes of domestic wastewater, unlike centralized urban wastewater treatment systems that pipe large amounts of wastewater many miles through sewers prior to reaching the treatment facility. Decentralized systems protect human health and water quality

[182] United States Environmental Protection Agency. Decentralized Wastewater Treatment Systems: A Program Strategy.

when they are properly sited, designed, installed, operated, and maintained. There is a range of technology options to choose from to make the decentralized systems more cost-effective and affordable.

Natural wastewater treatment systems can provide cheap solutions for wastewater treatment. The simplest system is a pond system, where the algal–bacterial symbiotic relationship is used for wastewater treatment. Some have also been used for tertiary treatment, such as duckweed pond systems, waste stabilization ponds, facultative pond, and constructed wetlands. Like other treatment systems, these systems are capable of removing the nutrient and organic load from wastewater. Natural systems are generally used in those places where there is large space available, but funds are limited.

Krong Preah Sihanouk, Cambodia has a wastewater treatment facility using waste stabilization ponds, with a capacity of about 6,900 m^3/day, and designed for an organic loading (BOD) of 1,380 kg/day. The treatment plant can be expanded in the future by duplicating stage 1, and by adding an airing equipment if organic loading exceeds design assumptions.

Aerobic treatment methods involve the use of oxygen utilized by microorganisms for degradation of organics into the simplest degradation products, i.e., CO_2 and water. These systems require forced aeration or mechanical aeration equipment. The footprint of these systems is smaller in comparison to natural systems, but energy consumption is high. Most wastewater treatment facilities use the conventional activated sludge (CAS) technology. Newer facilities use modern technologies like the membrane bioreactor (MBR), which is an adaptation of the CAS process. Due to land or space constraints, a variant of the centralized wastewater treatment system—'cluster wastewater treatment'—is being applied to collect and treat waste from multiple households in a village. There could be multiple clusters rather than one centralized system for a city. **Table 12.7** shows the technical and cost comparisons of technology options for cluster wastewater treatment in areas with limited land like Metro Manila, Philippines. Common characteristics of these options are: (a) low space requirement; (b) operational flexibility and control; (c) stability and efficiency in process performance; (d) cost-effectiveness; and (e) equipped for tertiary treatment or nutrient removal. These systems are also capable of satisfying the discharge standards of various developed countries.

Table 12.7: Comparison of Technology Options for Wastewater Treatment, Metro Manila.

Location	Year of Construction	Capacity (m^3/Day)	Technology Applied	Cost Of Construction ($'000)	Unit Cost ($/$m^3$)	Land Requirement (m^2)
Baesa	2012	390	STM®-Aerotor	274	703	287
A. Samson 2	2012	1,900	STM®-Aerotor	1,669	878	917
Tandang Sora	2012	1,200	STM®-Aerotor	1,391	1,159	402
Paltok	2012	4,900	MBBR	4,164	850	1,091

Table 12.6: Comparison of Technology Options for Wastewater Treatment, Metro Manila. (cont.)

Location	Year of Construction	Capacity (m^3/day)	Technology Applied	Cost Of Construction ($'000)	Unit Cost ($/$m^3$)	Land Requirement (m^2)
Del Monte	2012	3,510	MBBR	4,585	1,306	574
San Antonio	2012	3,130	MBBR	4,581	1,384	605
Paco	2012	410	MBBR Johkasou	663	1,617	500
Bahay Toro	2012	13,400	Modified Activated Sludge	6,101	455	4,128
Baesa	2012	390	STM®-Aerotor	274	703	287
A. Samson 2	2012	1,900	STM®-Aerotor	1,669	878	917
Tandang Sora	2012	1,200	STM®-Aerotor	1,391	1,159	402
Paltok	2012	4,900	MBBR	4,164	850	1,091
Del Monte	2012	3,510	MBBR	4,585	1,306	574
San Antonio	2012	3,130	MBBR	4,581	1,384	605
Paco	2012	410	MBBR Johkasou	663	1,617	500
Bahay Toro	2012	13,400	Modified Activated Sludge	6,101	455	4,128
Bagbag	2012	10,400	SBR	5,444	523	3,516
Tatalon	2012	8,100	SBR	4,758	587	2,065
Congressional	2012	570	SBR	550	965	620
Grant	2012	620	SBR	740	1,194	290
Legal	2012	410	SBR	646	1,577	460

Note: m^2 = square meter; m^3= cubic meter; MBBR = moving bed biofilm reactor (fixed film technology); SBR = sequencing batch reactor (activated sludge process); STM Aerotor uses Integrated Fixed Film and Activated Sludge.
Source: F. Arellano. 2014.

Dagat-Dagatan waster stabilization ponds

Paco WWTP using Johkasou tanks and moving bed biofilm reactor

Tank for reuse of treated wastewater

Taguig septage treatment plant (CAS)

Sequential batch reactor in Project 7 WWTP

Tandang Sora WWTP using STM Aerotor

Photos by M. Ebarvia

12.4.2 Wastewater Management and Reuse: Circular Economy

A circular economy is one in which economic development and environmental sustainability are interdependent, with a strong emphasis on minimising pollution, while maximising reuse and recycling.

What if we were to consider the vast quantities of domestic, agricultural, and industrial wastewater discharged into the environment everyday as a valuable resource rather than a costly a problem? That is the paradigm shift called for in the *2017 United Nations' Water Development Programme's World Water Development Report (WWDR) – Wastewater: The Untapped Resource*.

From this perspective, wastewater is an untapped resource of unparalleled potential. When safely treated, wastewater can be a source of water, energy, nutrients, and other recoverable materials. The management of wastewater in coastal urban areas and upstream regions is essential as it is inextricably linked to overall coastal and ocean management objectives. In Singapore, the highly treated wastewater, dubbed NEWater, satisfies up to 40 percent of the country's current water demand according to the Public Utilities Board.

Reusing treated wastewater for irrigation and non-potable uses

Previously, wastewater management was conducted as a straightforward process of collecting and treating wastewater, and then discharging the treated effluent according to government-imposed regulations. However, technologies have evolved, enabling wastewater to be treated and reused extensively for irrigation, which significantly contributed to reducing freshwater usage.

In Viet Nam, treated wastewater provided subsistence farmers and ethnic minorities in Buon Ma Thuot, Dak Lak Province with reliable source of water year-round for irrigating around 115 ha of agricultural land and coffee plantation (ADB, 2014).

Tadotsu, a town in Shikoku Island in Japan, is characterized by low rainfall. Treated wastewater is being reused for river restoration; irrigation for crops, parks and gardens; groundwater recharge; and augmentation of the streams and brooks running through the town. Wastewater reuse created positive economic impact on agriculture, tourism, and associated industries (ADB 2016).

Some resorts in Indonesia and the Philippines are using the treated wastewater for flushing toilets and watering plants and gardens in the resorts.

Reusing sludge from wastewater treatment as soil conditioner and fertilizer

To further enhance the resource recovery loop, technologies were further refined to allow usage of wastewater treatment by-products. In the Philippines, China and Japan, sludge is further treated for use as organic fertilizers and soil conditioners.

Biogas from wastewater treatment

The field of wastewater management provides a good example of a holistic and integrated approach in dealing with the water and energy dependencies. As alternative energy and fuel source, biogas has resulted in reduction of carbon emissions, and generation of carbon credits.

Biogas from methane recovery from the wastewater treatment process has various uses. In the biogas digester project of SNV Netherlands, a non-government organization working with the governments of Cambodia, Viet Nam, and Lao PDR, the biogas generated from wastewater treatment is used for lighting, cooking and heating purposes in the rural communities.

Biogas is also used for generation of electricity, which can sometimes be directed or sold back to the power grid, such as in Nakhorn Ratchasima, Thailand.

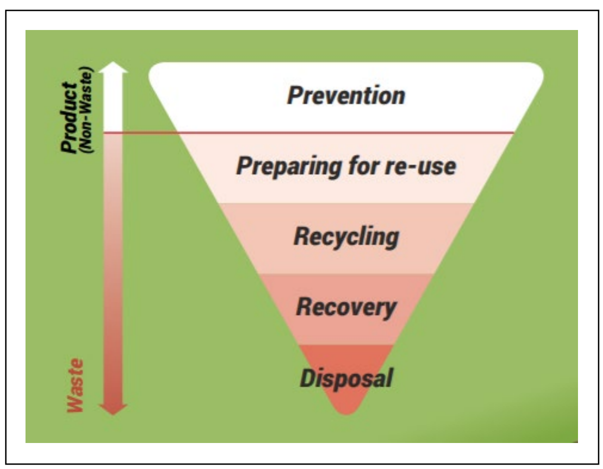
In Kobe, Japan, biogas from its Higashinada wastewater treatment plant (WWTP) is used not only inside the WWTP but also as fuel for buses, garbage trucks, and other vehicles, and as city gas in the distribution network of Osaka Gas. This WWTP contributes to the reduction of 2,700 tonnes of GHG emissions per year (ADB, 2016).

12.4.3 Solid Waste Management and Circular Economy

Thirteen targets from five SDGs (SDG 6, 11, 12, 14 and 15) are relevant to reducing the inputs and impacts of plastic waste on terrestrial and marine ecosystem.

The countries in the EAS region have very high material footprint, including plastic footprint. Transitioning to a circular economy, including reducing plastics use, recovering their post-use value, recycling, and increasing the reusability of products, involves having an effective solid waste management system and more sustainable consumption and production. The circular economy also presents opportunities for green jobs and community-level solutions.

Figure 12.4: Waste Hierarchy for Sustainable Waste Management.



Source: EU Waste Framework Directive (Directive 2008/98/EC on waste).

The EAS countries need to collaborate with other countries in developing and implementing trade policies that can be used to tackle the plastic pollution problem. Collective action among countries is necessary to put in place measures to reduce, substitute, collect, recycle, and sustainably dispose plastics with harmonized global rules worldwide.

Indonesia

In 2017, the circular economy concept was introduced in Indonesia with three pilot **Zero Waste** project communities: Bandung, Cimahi, and Soreang. Within just the first year, #ZeroWasteCities reached 3,640 households or around 14,560 people. The program was responsible for keeping 950 kg of waste each day out of landfills, saving about IDR 63 million (US$ 4,300) in transportation costs in the pilot sites for that year.

To reduce the volume of waste going to the disposal sites, the Ministry of Environment and Forestry (MOEF) of Indonesia promotes **Waste Banks** as a strategic program to involve informal community-based efforts to collect sorted inorganic waste that has economic value. Decentralized waste banks are set up in neighborhoods typically with about 1000 residents and are usually run by poorer people who wish to increase their income. The collected inorganic wastes are sold to recycling companies. One example is Citarik village in Palabuhanratu in Sukabumi Regency, which has a community-based waste management bank. Established in 2015, the bank reduces garbage while generating income by converting much of the waste into organic fertilizer and through the sale of recyclable materials. Its aim is to reduce waste by 50 percent in the next five years. The Regency aims to establish 100 similar waste banks in the next three years.

Cambodia

It can be noted that since 2018, the Royal Government of Cambodia has promoted the 4Rs – Refuse, Reduce, Reuse, and Recycle – framework to tackle plastic pollution. The **Circular Economy Strategy and Action Plan** of Cambodia has also been drafted (with support from Sweden and the UNDP), as one of the policies that promote the implementation of the 4Rs. One example of a government initiative is the imposition of a small levy on plastic bags, targeted at supermarkets and shopping centers. It was reported that this levy has successfully reduced the use of plastic bags by more than 50 percent for major supermarkets. The funds collected from this levy are used to support green initiatives throughout Cambodia. These include the installation of water fountains and solar panels in public schools to help build more eco-friendly schools and public spaces. The government is currently drafting additional regulation on single-use plastics. Major industries using single-use plastic like plastic bottles need to create product designs that are easily recyclable and actively support recycling.

Philippines

The *Philippine National Solid Waste Management Strategy, 2012-2016* was created to implement feasible waste management programs in government agencies, private institutions, and the general public. Programs like the *Waste Analysis and Characterization Study* identify the volume, percentage in weight or its volumetric equivalent, material type, and source of generation, which includes residential, commercial, industrial, governmental, or other sources. It is used as a tool for informed decision-making for proper waste segregation, collection, and management.

All local government units (LGUs) were required to formulate a 10-year Solid Waste Management Plan that should be consistent with the objectives stated by the Philippine National Solid Waste Management Framework. Eight of the 17 regions are 100 percent compliant, and another eight have 92 to 98 percent compliance rate as of 2017. A key challenge is the implementation of these 10-Year SWM Plans and monitoring their effectiveness.

The Solid Waste Management Plan requires all barangays to allocate a parcel of their land for a Material Recovery Facility (MRF). The MRF collects mixed waste for sorting, segregation, recycling, and composting. Recyclables are sold to junk shops and recycling companies. The residual waste is then transferred to a sanitary landfill for long-term disposal. As of 2017, there were 10,052 MRFs established in different barangays.

Solid waste to bricks

Biodegradable waste to fertilizer

Waste to energy facility at a landfill

Photos by M. Ebarvia

Singapore

Singapore has put in place a solid waste management system to ensure that all waste is collected and treated to safeguard environmental public health standards. The system is based on the principles of providing a cost-effective infrastructure while minimising land-take, and promotion of the 3Rs (reduce, reuse and recycle) to reduce waste and recover resources. While Singapore aims to achieve an overall national recycling rate of 70 percent by 2030 as part of the *Sustainable Singapore Blueprint 2015*, the ultimate goal is to work towards becoming a **Zero Waste Nation**.

All incinerable waste that is not recycled is incinerated at waste-to-energy (WTE) plants to reduce the waste volume by 90 percent. To complement ferrous scraps recovered at the WTE plants, Singapore's first metal recovery facility for incineration bottom ash began operations in July 2015.

Only non-incinerable waste that is not recycled is directly landfilled to reduce landfill needs. Semakau Landfill is Singapore's only landfill. It is an offshore landfill with a 7-km perimeter bund built to enclose a part of the sea off two islands, Pulau Semakau and Pulau Sakeng, to create a 350-ha landfill. The bund is lined with impermeable membrane to prevent pollution of the sea. The leachate produced is treated at a leachate treatment plant.

Moving forward, the National Environment Agency (NEA) will build the *Integrated Waste Management Facility* (IWMF). The IWMF will also be co-located with PUB's *Tuas Water Reclamation Plant* to reap the benefits of various process synergies. The IWMF will be built in two phases and expected to be fully completed by 2027.

Waste Minimisation and Recycling. To reduce waste at source, NEA works with industry and non-governmental organisations (NGOs), and jointly initiated the *Singapore Packaging Agreement* (SPA), a voluntary agreement to reduce packaging waste. To promote recycling, NEA collaborates with schools in implementing the *School Recycling Corner Programme* since 2002. Under the programme, recycling bins and recycling information are provided. NEA also engages industry to promote 3Rs and build up capabilities in 3Rs. For instance, NEA worked with various industry sectors and stakeholders to roll out *3R guidebooks for hotels and shopping malls*, as well as a *3R toolkit for the Meetings, Incentives, Conventions and Exhibitions (MICE) industry*.

12.4.4 Marine Plastic Debris Management

Indonesia

In 2017, the Government of Indonesia has initiated the management of marine debris by issuing Indonesia's **Plan of Action on Marine Plastic Debris 2017-2025**. It reinforces existing environment policies and laws, and its aim is to reduce is marine plastic debris by 70 percent by 2025. Funds have been made available for R&D of alternatives to plastic. There are also local initiatives on banning use of plastic bags and containers.

RO Korea

Korea's marine debris management policy was implemented following the **Basic Plan for Marine Debris Management**, which is established every five years based on the *Marine Environment Management Act*. In the past, Korea's marine debris management has focused on collection and disposal, but the focus has now shifted toward the prevention and strengthening of management platforms. The Second Plan (MOF et al., 2013) aims to strengthen management at its source and to build a statistical surveying system to narrow the knowledge gap. The national policy regarding marine debris management is likely to be refined based on studies, which provide quantitative data about the inflow and distribution of marine debris, including microplastics, and surveys that identify the social, economic, and environmental impacts of marine debris. Additionally, further public education to raise awareness among people engaged in fisheries will help in reducing marine debris. Research in the field of social science needs to be conducted to determine why fishermen discard DFG at sea and how this behavior can be prevented.

Viet Nam

At the 6th General Meeting of the Global Environment Fund (GEF 6) in June 2018, at the sideline event "Marine litter" organized by the Ministry of Natural Resources and Environment (MONRE) of Viet Nam, the Minister of MONRE proposed the initiative of "*Establishing a Partnership for the East Asian Seas free of plastic waste*". This initiative is to promote cooperation and share information, knowledge, and experience on ocean waste management among countries in the region with international and local organizations; build capacity to transform the consumption-based economy to a circular economy as well as mobilize the participation of manufacturers at all levels.

Viet Nam has adopted specific actions related to solving the problem of ocean plastic waste. The country has developed its **National Plan of Action on Ocean Plastic Waste to 2030**. The goal of this Plan is to manage ocean plastic waste from both land and sea, following a circular economy approach, to create breakthroughs and changes in awareness and behavior of the whole community in the production, consumption and disposal of plastic products and collection and treatment of plastic waste. Corresponding activities like anti-plastic waste campaign, waste segregation, and beach cleanup, have been undertaken in key coastal areas, such as the Xuan Thuy National Park and the Red River biosphere reserve, Cu Lao Cham - Hoi An World Biosphere Reserve, and Ha Long Bay to protect the coastal and marine environment. This is in line with *Integrated Coastal Management (or ICM) Strategy for Viet Nam until 2020, vision to 2030; Action Plan on Implementing National ICM Strategy* until 2020, vision to 2030; *National Strategy for Biodiversity until 2020, vision to 2030*; and the *Strategy for Viet Nam's sustainable ocean economy development to 2030, vision to 2045*.

Mekong River Basin

At a regional workshop held in February 2020, in Vientiane and hosted by the Mekong River Commission Secretariat and UNEP Regional Office for Asia and the Pacific, 50 government officials and university researchers from Cambodia, Lao PDR, Thailand and Viet Nam discussed the assessment of plastic debris and its sources across the Mekong River basin. It was held as part of the Japan-UNEP's "Counter-MEASURE" project, which promotes countermeasures against marine plastic litter in Southeast Asia and India. The findings of the assessment studies in these countries will be incorporated in the next *State of the Mekong River Basin* report. Previous state of the basin reports did not include plastic waste as one of the indicators. Through the project, a Mekong strategic framework for plastic pollution management will be developed, and networks across the four countries for the monitoring and management of the Mekong plastic pollution will be created.

12.4.5 Oil Spill Contingency Planning and Response

ASEAN

The ASEAN **Regional Oil Spill Contingency Plan**, which was adopted in 2019, provides for a mechanism whereby ASEAN Member States can request for and provide mutual assistance in response to any oil spills. It also ensures a common understanding to enable the effective integration between the affected and assisting ASEAN Member States, in the event of incidents involving oil spills.

One of the key elements in oil spill contingency planning is to define the communication channels to be used by cooperating parties when facing an incident. A workshop in Pulau Indah, Klang, Malaysia (19-21 August 2019) has brought together officials from ASEAN states to help bring into operation the Regional Oil Spill Contingency Plan.[183] The workshop was carried out under IMO's Integrated Technical Cooperation Programme, and the framework of the Global Initiative project for South-East Asia (GI SEA), a joint project with the oil and gas industry (IPIECA). It supports the implementation of the OPRC. Participants from nine countries were trained on the key elements of the plan and practiced communications between States, in order to identify any gaps and lessons to be learned. The workshop will help drive forward the implementation of the regional plan.

Gulf of Thailand

Another sub-regional agreement, the *Joint Statement on Partnerships in Oil Spill Preparedness and Response in the Gulf of Thailand* (GOT), provides an example of inter-governmental cooperation that is not covered by a regional convention. The joint statement and framework programme provides a common cooperative platform for enhancing capacities and implementing an effective response system for oil spills in the respective countries. It also promotes mutual assistance and international cooperation in oil spill-related programmes and activities, particularly in training, research and exchange of information, among others.

On 12 January 2006, ministers from three Gulf of Thailand (GoT) littoral states, namely Cambodia, Thailand, and Viet Nam, signed the *Joint Statement on Partnership in Oil Spill Preparedness and Response in the Gulf of Thailand*, and endorsed the *Framework Programme for Joint Oil Spill Preparedness and Response in the GOT*. The framework aims to enhance national capacity and promote regional partnership in oil pollution prevention, preparedness, and response by exchanging information, research and conducting oil spill response exercises. It outlined the following strategies to strengthen policy and legal frameworks to develop and support national system for oil preparedness and response:

- Developing/enhancing national/local oil spill contingency plans
- Information sharing
- Joint training of relevant personnel
- Oil spill exercise conducted in partnership with IMO, ITOPF, NOAA, OSRL, and IESG.

PEMSEA provided technical support to participating countries in the preparation, adoption, and implementation of the framework.

[183] https://www.hellenicshippingnews.com/oil-spill-contingency-planning-in-south-east-asia/.

With support from IMO, KOICA, and PEMSEA, the *Environment Sensitivity Index (ESI) Atlas for the GOT* was developed through collaboration of sub-regional and national technical teams. The ESI Atlas provides maps to guide the planning and response to oil spill incidents. It is being used as reference during oil spill response exercises.

The GOT cooperation resulted in increased oil spill preparedness and response capability of the participating countries and a better understanding of the system of response in each country.

Northwest Pacific

The Northwest Pacific Action Plan (NOWPAP)'s *Regional Oil Spill Contingency Plan* was adopted in 2003, providing technical and operational guidelines for regional cooperation in case of an oil spill incident in the NOWPAP Region. The Plan provides a framework under which NOWPAP Members (China, Japan, RO Korea, and Russia) can cooperate at the operational level in responding to oil spill incidents. It is also referred to as an operational mechanism for mutual assistance. HNS has been recently added to the existing Plan and a corresponding Resolution (guidelines) was adopted in 2008. With this arrangement, the four member states are in a better state of preparedness to respond to oil and HNS spills, as each of them may request assistance from other NOWPAP members in cases of major oil and HNS spill incidents.

Other regional mechanisms

The *IPIECA Oil Spill Working Group* (OSWG), established in 1987, serves as a key international oil industry forum, which aims to improve the state of oil spill contingency planning and response around the world. IPIECA operates globally and seeks to achieve its vision through the following strategies: (a) developing, sharing and promoting sound practices and solutions; (b) enhancing knowledge management and information exchange; (c) engaging members and others in the industry and working in partnership with key stakeholders; (d) supporting joint industry-government cooperation at all levels; (e) encouraging ratification of relevant international conventions; and (f) promoting the principle of 'Net Environmental Benefit Analysis' and the tiered response concept when designing response strategies.[184] One of the popular works of IPIECA is the publication of technical reports - the *IPIECA Oil Spill Report Series*, which provides a practical and accessible overview of issues relevant to the preparation for and response to oil spills at sea.

At the regional level, *Oil Spill Response* (OSR), an oil industry tier 3 response organization with a global scope, operates a regional base in Singapore for the Asia-Pacific region, and has been an active partner of government entities in the region. For the past decades, OSR has implemented a pro-active advocacy program, assisting relevant government agencies in building oil spill response capacities. The OSR operates on a tiered preparedness and response concept, which is considered

[184] www.ipieca.org.

as the most efficient and effective way to sustainably meet operational challenges for oil spill response. The OSR is part of the *Global Response Network*, a collaboration of seven major oil industry-funded spill response organizations whose mission is to harness cooperation and maximize the effectiveness of oil spill response services worldwide.

Oil spill at Ao Phrao, Koh Samet in Rayong Province *(Photo from TEI)*

12.4.6 Incentives and Partnerships

Voluntary Agreements: Indonesia's rating of industries

One form of incentive is giving of awards and recognition for an industry's effort to go green. A rating system is being applied by Indonesia's MoEF for the monitoring and evaluation of industries, and their compliance to environmental regulations. The **Program for Pollution Control, Evaluation and Rating** (PROPER) was launched as the first major scheme in Indonesia that was used as **disclosure of information** to the public and measurement of environmental performance. This is in support of the green economy initiative of the government, and reduction of impacts on the rivers and coastal waters.

PROPER assessment criteria consist of two categories, namely, (1) compliance assessment criteria, and (2) beyond compliance assessment criteria. A company will receive a **black rating** if it pollutes or damages the environment, or no attempt has been made to manage the environment. A company will receive a **red rating** if it has not been able to meet the environmental regulations, but already have efforts to improve its management of the environment. If the company has complied, then it will be awarded **blue rating**. When an industry goes beyond the compliance requirements, then it could either receive a green or gold rating. In order to obtain a green and gold assessment, companies must first adhere to the regulations or a rating of blue. Assessment of **green rating** is based on benchmarking the performance of corporate environmental management in the implementation of environmental management systems, energy efficiency, emissions reduction, 3R toxic waste and solid waste management, water conservation, reduction of pollution load, biodiversity protection, and the implementation of community empowerment. **Gold rating** is awarded to the best and most consistent companies in managing the environment.

In 2016, the number of participants to PROPER reached 1930 companies consisting of 111 types of industries. PROPER's compliance rate in 2016 reached 85 percent[185] with:

- EMAS (gold): 12 companies
- HIJAU (green): 172 companies
- BIRU (blue): 1422 companies
- MERAH (red): 284 companies
- BLACK: 5 companies
- 35 other companies not announced consisting of 13 companies under law enforcement process and 22 companies closed / not operating.

In 2017-2018, 1,872 industries were evaluated, and around 13 percent of the industries failed to comply with the environmental regulations.[186] Lack of pollution prevention policies, especially for small-scale industries/enterprises and insufficient capacity of wastewater treatment plants are the key reasons.

Table 12.8: PROPER Compliance Trends (2011-2016).

Year Period	Rank					Under Law Enforcement	Not Announced
	Gold	Green	Blue	Red	Black		
2011	5	106	552	283	49	-	7
2012	12	119	771	330	79	-	6
2013	12	113	1039	611	17	-	20
2014	9	121	1224	516	21	-	17
2015	12	108	1406	529	21	24	17
2016	12	172	1422	284	5	13	22

Source: Permen LH Nomor 5 Tahun 2011, Kepmen LH Nomor 273 Tahun 2012, Kepmen LH Nomor 349 Tahun 2013, Kepmen LH Nomor 180 Tahun 2014, Kepmen LH Nomor SK.557/MenLHK-Setjen/2015, dan Kepmen LH Nomor SK.892/Menlhk/Setjen/SID.0/12/2016.

185 PEMSEA and MOEF (Indonesia), 2020.
186 MOE (Japan), 2019.

13 The Blue Diamonds: Coastal and Marine Ecosystems and Biodiversity

"This is the Ocean, silly, we're not the only two in here."
Dory (Finding Nemo)

Key SDG targets:

- **SDG 14:**
  - **Target 14.2**: By **2020**, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans.
    - ◊ **Indicator 14.2.1**: Protect and restore ecosystems.
  - **Target 14.5**: By **2020**, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.
    - ◊ **Indicator 14.5.1**: Protected marine areas.

- **Key Aichi Biodiversity targets:**
  - **Target 2**: By **2020**, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
  - **Target 10**: By **2015**, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.
  - **Target 11**: By **2020**, at least 17 per cent of terrestrial and inland water, and ***10% of coastal and marine areas***, especially areas of importance for biodiversity and ecosystem services, are conserved…
  - **Target 15**: By **2020**, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including ***restoration of at least 15 percent of degraded ecosystems***, thereby contributing to climate change mitigation and adaptation and to combating desertification.

13.1 Status of Coastal Habitats

The EAS region is home to one-third of the world's mangroves, coral reefs, and seagrass beds. Various reports show different estimates of the areal extent of the coastal and marine ecosystems, creating uncertainty on their actual condition (**Table 13.1**). More importantly, these coastal ecosystems are being destroyed as they face a myriad of social, environmental, and climate change crises. The benefits and ecosystem services would be lost, affecting lives, livelihoods, and security of the people in the region. This should force governments to increase awareness of the need for closer collaboration with communities and stakeholders, adaptive and integrated management, and inter-disciplinary research and monitoring linked to policy and practice in order to protect ecosystems and biodiversity and sustain the benefits they generate.

Table 13.1: Coastal and Marine Habitats in the EAS Region.

Country	Mangroves (km^2)		Coral Reefs (km^2)		Seagrass (km^2)		Tidal Flats; Mudflats (km^2)	Coastal Wetlands (km^2)
	(a)	(b)	(a)	(b)	(b)	(c)		
Brunei Darussalam	173		210			1.5		
Cambodia	72	508.6[d]	<50	28.05[d]	324.94[d]	324.9	545[d]	
China	208	220.249[e]	1,510		67.651[e]			57,959[c]
DPR Korea	--	--	--	--	--			
Indonesia	31,894	336,680.756[f]	51,020	25,000.0[g]	1,506.936[f]	8,812.9		
Japan	7.4		2,900					
Malaysia	7,097	6,275.7[h]	3,600	4,006[h]	16.3[h]	16.3		
Philippines	2,565	3,033.73[i]	25,060	7,977.19[i]		27,262,2	2,000[i]	
RO Korea	--	--	--	--			2,489[j]	
Singapore	4.6	6.59[k]	<100	1.26[k]		0.3	15.84[l]	
Thailand	2,484	4,591.18[m]	2,130	238.3[m]	255.7[m]	148.5		41.4[n]
Timor-Leste	18	2.9[o]		100.3[o]	23.78[o]		3.28[o]	
Viet Nam	1,056	2,131.42[p]	1,270	86.71[p]	160.0[p]	157.4		
TOTAL (EAS)	**46,062**		**87,640**			**36,728.3**		
WORLD	150,398		284,300					

[a] *World Bank 2017. The Little Green Data Book 2017.*
[b] *NSOC Reports*
[c] *Fortes, et al. 2018*
[d] *Cambodia: Ministry of Environment (2013); Department of Fisheries*
[e] *China: NSOC Report of China, 2018 (unpublished); China Marine Statistical Yearbook 2016*
[f] *Indonesia: BPS, Statistics of Coastal and Marine Resources 2016; NSOC Report of the Indonesia 2020*
[g] *Indonesia: P2O-LIPI 2017; Hermawan, et al. 2017; NSOC Report of the Indonesia 2020*
[h] *Malaysia: NSOC Report of Malaysia, 2018 (unpublished)*
[i] *NSOC Report of the Philippines 2019.*
[j] *NSOC Report of RO Korea 2019*
[k] *Singapore: National Parks Board; NSOC Report of Singapore 2019*
[l] *intertidal: including seagrass, mudflats, reef flats, rocky shores, and sandy beaches*
[m] *NSOC Report of Thailand 2019*
[n] *beach forest*
[o] *NSOC Report of Timor-Leste 2019*
[p] *NSOC Report of Viet Nam 2021*

Dugong on a seagrass meadow in Palawan, Philippines.
(Photo by diveplanit.com DPI-6660)

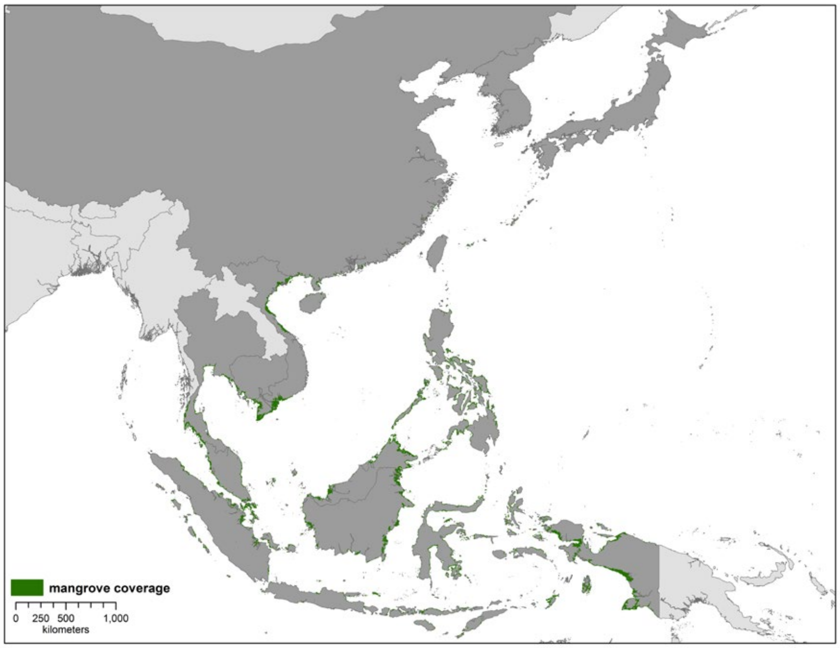
13.1.1 Mangroves: The Forests by the Sea

Mangrove forests are found in the intertidal zone of tropical coastlines and estuaries. They are made up of different types of mangrove trees and a wide variety of plants. Different mangrove species are adapted to serve different functions depending on their location.

Mangrove plants belong to 20 families, 22-27 genera and around 60 species (Tomlinson 1986; Duke 1992), of which around 40 exclusive species and 65 non-exclusive species are found in Southeast Asia (Japar 1994; Spalding et al. 1997).

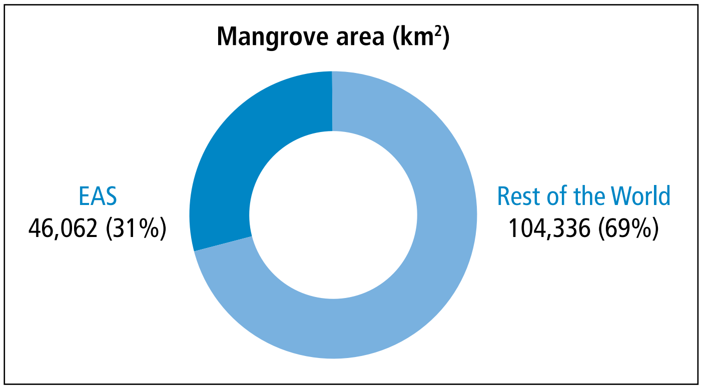
The location of mangrove forests in the countries in the EAS Region is shown in **Figure 13.1**. The EAS region accounts for 31 percent of the total mangrove area in the world (**Figure 13.2**).

Figure 13.1: Location and Coverage of Mangrove Forests.



Source: Spalding, 2010.

Figure 13.2: Area of Mangroves.



Source of data: World Bank, 2016.

Value of mangroves

Straddling the interface of land and sea, mangrove forests are of two worlds. The mangrove tree has roots and leaves that filter salt and other materials.

Mangroves provide a number of benefits for coastal human communities. Their role as fish nurseries can have big impacts on local economies, food production and security. The major ecosystem services that mangrove provide are the following:

- The mangrove ecosystem is a renewable resource (but depletable if not conserved and managed properly) that provides huge numbers of people with food, tannins, fuelwood, construction materials, and even medicines.
- **Habitat and nursery role to other species.** A crucial component of the coastal ecosystem and a powerful form of erosion control, mangrove trees provide shelter and nutrients to their ecosystems. These shallow, nutrient rich areas provide shelter to young fish, shrimps, crabs, and molluscs. Hundreds of bird species migrate and nest in mangrove forests. Other animals that inhabit mangrove forests include manatees, dugong, sea turtles, fishing cats, monitor lizards, and mud-skipperfish. Not only do mangrove trees directly support countless food webs, but they are also indirectly responsible for the survival of the most primary planktonic and epiphytic algal food chains, which in turn provide carbon for the mangrove tree.
- **Shoreline protection.** Mangroves act as storm barriers, protecting coastlines from storm surge and tsunamis, and inland areas from flooding and erosion by dissipating the energy of big waves. Mangroves offer protection of property and life from hurricanes and storms, and reduce immediate damage and future reconstruction costs.
- **Control of erosion, siltation, and sedimentation.** Erosion is avoided when mangroves take on the force of the waves and help replace lost sediment by catching suspended particles in their root system while simultaneously keeping that same silt from covering (and damaging) coral reefs and seagrass beds.
- **Waste assimilation.** Mangroves help filter river water of pollutants and trap excess sediment before it reaches the ocean. Plants in mangrove forests can absorb nitrates and phosphates, cleaning up and restoring water near the shore in a natural and completely cost-free manner.
- **Carbon sequestration.** Mangroves are powerhouses when it comes to carbon storage. Studies indicate that mangroves can **sequester ten times more carbon** and **store three to five times more carbon** than rainforests can. Most of this carbon is stored in the soil beneath mangrove trees. Sanderman et al. (2018) suggests the real value of mangroves

may be higher considering that much more carbon may be locked up in mangrove soil than previously believed. According to this study:[187]

- The study finds mangrove soil held around 6.4 billion tonnes of carbon in 2000. This is dramatically higher than previous estimates that pegged the carbon content of mangroves (both soil and biomass) at around 4.19 billion tonnes.
- This study also indicates that between 2000 and 2015, between 30 million and 122 million tonnes of soil carbon was released due to mangrove forest loss, resulting in emissions of between 111 million and 447 million tonnes of $C0_2$.
- More than 75 percent of these soil carbon emissions came from mangrove deforestation in just three countries: Indonesia, Malaysia, and Myanmar (**Table 13.2**).

Table 13.2: Mangrove Area and Loss in Southeast Asian Countries, 2000-2012.

Country	Total mangrove in 2000 (ha)	Mangrove deforestation (ha)	Mangrove habitat area lost (ha)	Percentage mangrove loss 2000-2012 (%)
Indonesia	2,788,683	60,906	48,025	1.72
Myanmar	502,466	27,957	27,770	5.53
Malaysia	557,805	18,836	15,809	2.83
Thailand	245,179	3,504	3,344	1.36
Philippines	257,575	1,423	1,296	0.50
Cambodia	47,563	1,218	1,086	2.28
Viet Nam	215,154	531	528	0.25
Brunei Darussalam	11,054	48	41	0.37
Timor-Leste	1,066	2	2	0.19
Singapore	583	0	0	0
SOUTHEAST ASIA	4,626,545	114,424	97,901	2.12

Note: Countries are ordered by total mangrove lost. Mangrove habitat lost takes into account mangrove regrowth in deforested areas during the period.
Source: Richards and Friess, 2015.

Pressures

Mangroves are deforested for many reasons, including to make room for shrimp farms and other forms of aquaculture, salt farms, sea ports, airports, tourism facilities, commercial establishments, industrial zones, rice agriculture (in Myanmar), and palm oil plantations (Malaysia and Indonesia). They are also harvested for their wood. Deforestation and overharvesting threaten the future of mangroves.

[187] Sanderman *et al.*, 2018.

Fertilizers, pesticides, sewage, and other toxic man-made chemicals carried by river systems from upstream sources can kill animals living in mangrove forests, while oil pollution can choke mangrove roots and suffocate the trees. Increased erosion and siltation due to upland deforestation can massively increase the amount of sediment in rivers. This affects the mangrove's filtering ability, leading to a dying mangrove forest.

Mangroves also depend on the presence of freshwater and can die when dams and other developments stem the flow of rivers. If salinity is too high, the mangroves cannot survive. Diverted freshwater can lead to mangroves drying out.

Scientists also believe they are at risk of mass drowning as global warming raises sea levels.[188] The mangrove forests require stable sea levels for long-term survival. Coastal habitats are already getting flooded, and corals bleached. Coral reefs provide the first barrier against currents and strong waves. When destroyed, the stronger-than-normal waves and currents reaching the coast can undermine the fine sediment where mangroves grow. This prevents seedlings from taking root and washes away nutrients essential for mangrove ecosystems to thrive.

Proboscis Monkey in the mangrove forests of Sabah *(Photo by Tan Kim Hooi)*

13.1.2 Tidal Swamps and Salt Marshes: The Least Understood of the Coastal Ecosystems

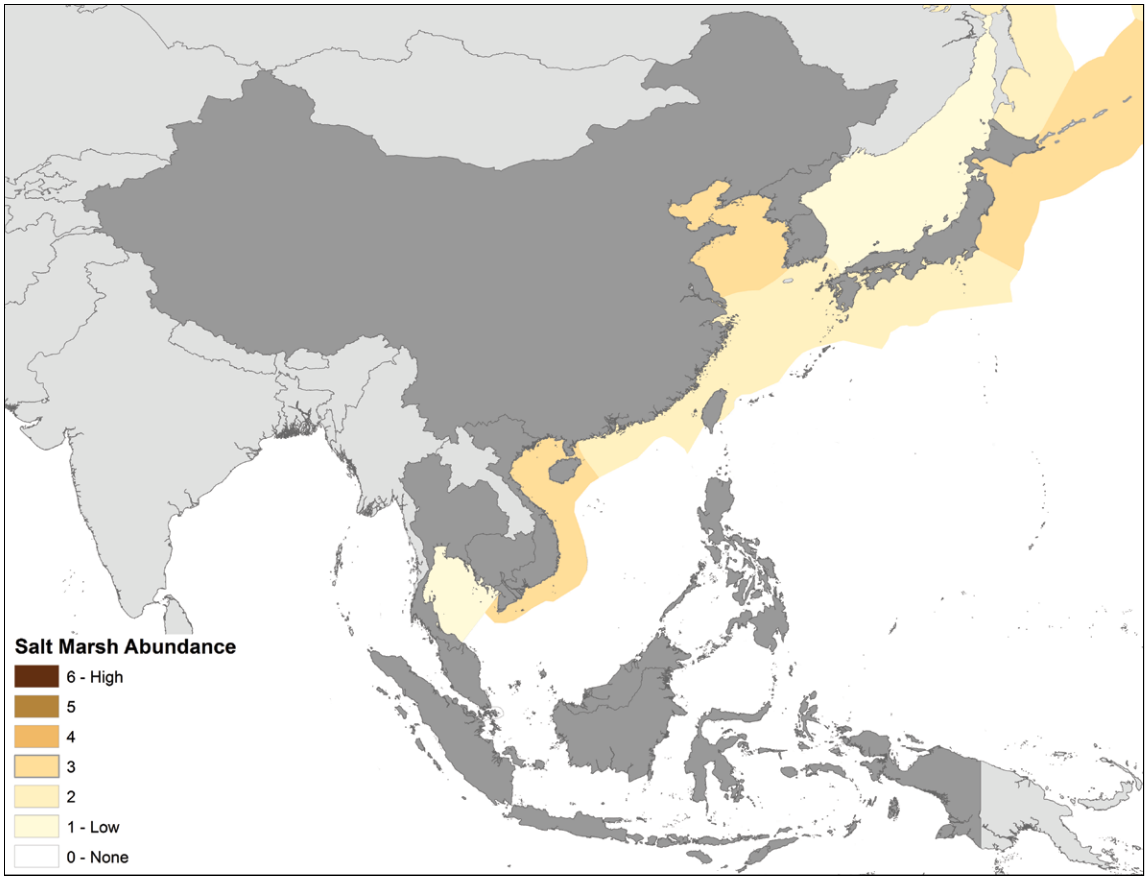
Salt marshes, also known as tidal marshes, are coastal wetlands that are regularly flooded with salty seawater that is brought in by the tides. Salt-tolerant plants such as grasses, sedges, and

[188] Sanderman *et al.*, 2018.

reeds sprout up from the soggy ground, painting the landscape shades of grays, browns, and greens. Their deep, mucky soils are made up of mud and peat, the latter of which is a spongy material consisting of decomposing plant matter. In EAS region, tidal marshes occur primarily in China, Japan, DPR Korea and RO Korea.

The UNEP-World Conservation Monitoring Center (WCMC) compiled the first global dataset specifically on salt marsh distributions; however, the data remain limited in terms of extent.[189] They estimated the relative abundance of salt marshes based on the proportion of coastline within a given region and created an abundance index (**Figure 13.3**). In the absence of data, it is speculated that no more than 60,000 ha of tidal marsh remains across the region. In China, it was reported that 708,200 ha of salt marshes have been drained, diked, or otherwise modified for aquaculture, rice cultivation and development.[190] The paucity of information on salt marshes in the region indicates that is a critical need for monitoring, and a tidal marsh change detection analysis, spanning at least a ten-year period.

Figure 13.3: Relative Abundance of Salt Marsh Habitat Based on Proportion of Coastline within a Region.



Source: Hoekstra, J. M. et al. 2010; Crooks, et al. 2017.

[189] Hoekstra, J. M. *et al.*, 2010.
[190] Shi-Jun, Y. and C. Ji-yu. 1995.

Black-face spoonbill in Songdo Tidal Flat, RO Korea *(Photo by Incheon Metropolitan Government)*

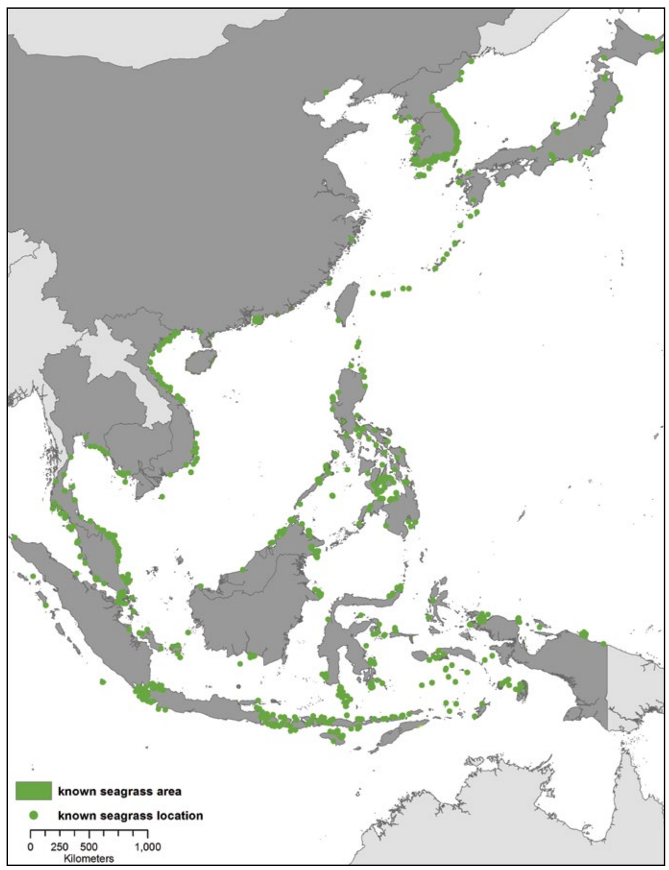
13.1.3 Seagrass: The Wonder Plants Beneath the Waves[191]

Seagrasses are flowering plants that spend and complete their life cycles under water, forming extensive meadows in many shallow coastal waters worldwide. To persist, seagrasses must have access to sunlight, sufficient immersion in seawater, and adequate rooting substrate to avoid being washed away by tides and currents.[192]

Seagrass can be found in all countries in the EAS region (**Figure 13.4**).

Based on a study in 2018, the extent of seagrass meadows in Southeast Asia is ~36,762.6 km^2, but this is likely an underestimate as some ecoregions were not well-represented and updated information was lacking.[193] The largest areas are in the Palawan/North Borneo (20,115 km^2), Eastern Philippines (7159 km^2), and Banda Sea (8246.2 km^2) ecoregions, all of which are part of the Western Coral Triangle.[194]

Figure 13.4: Location and Coverage of Seagrass Beds in the EAS Region.



Source: Crooks et al., 2017.

[191] Information on seagrass in this section is from the Asian Centre for Biodiversity. (http://chm.aseanbiodiversity.org/index.php?option=com_content&view=article&id=169&Itemid=169), and Fortes et al 2018 paper.

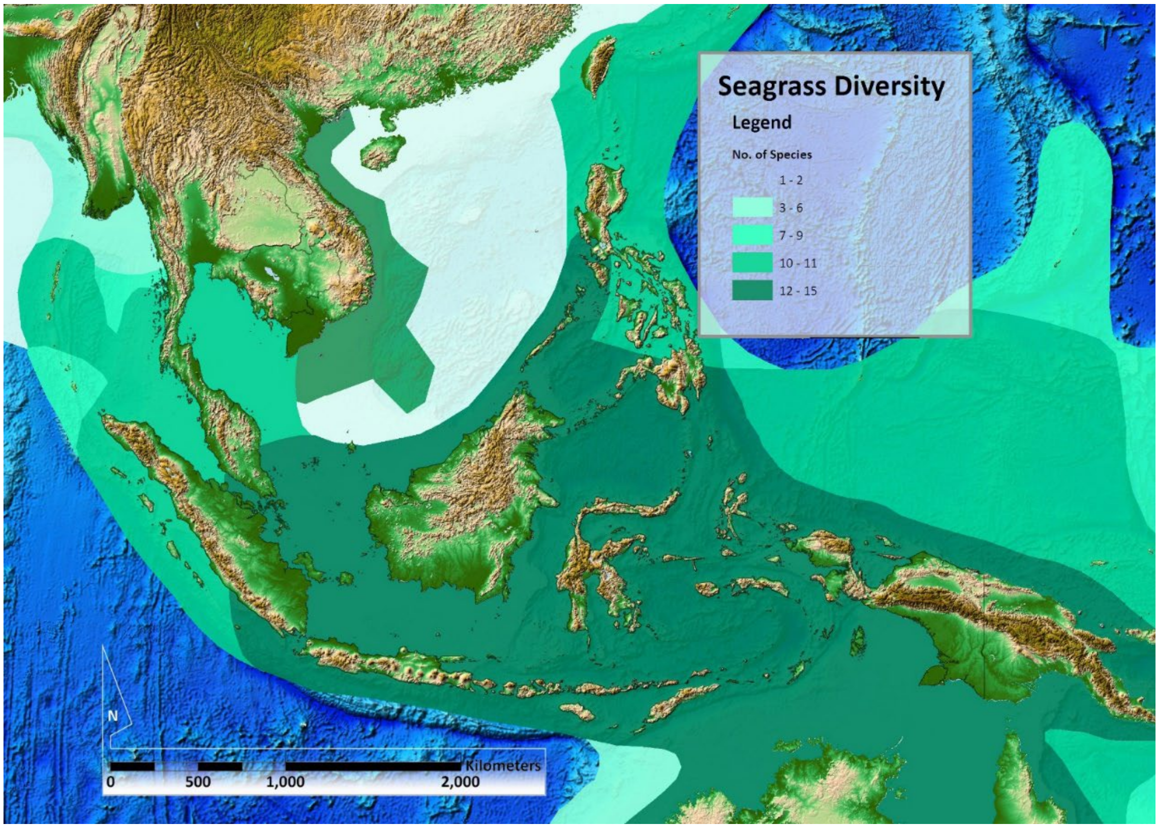
[192] McKenzie and Yoshida. 2009.

[193] Fortes *et al*., 2018.

[194] Fortes *et al*., 2018.

Southeast Asia has 18 of the world's 60 seagrass species and 33 percent of all seagrass areas on earth.[195] The Philippines, Malaysia, and Viet Nam have the most diverse numbers of species, with 16, 15 and 14 kinds of seagrass, respectively. The distribution map of seagrasses for the region may be seen on **Figure 13.5**. **Table 13.3** shows the areal extent and number of seagrass species by province and by ecoregion. Species richness at the province level is highest in the Sunda Shelf and Western Coral Triangle (15 species). The Malacca Strait emerges as an ecoregion of special interest in terms of species richness (14 species), considering that it is the busiest shipping lane in the EAS region.

Figure 13.5: Seagrass Diversity in Southeast Asia.



Source: UNEP-WCMC, 2005. Relief: USGS GTOPO30.

Value of seagrass

Seagrasses form the basis of a complex coastal ecosystem, supporting both threatened and economically important fishery species.[196] Seagrass ecosystems are one of the most productive coastal habitats in the region,[197] with a vital role and contribution to coastal fisheries. The monetary value of seagrass meadows has been estimated at up to $19,000 per ha per year, thus being one of the highest valued ecosystems on earth.[198]

195 Tun *et al*., 2004.
196 UNEP/GEF. 2004.
197 McKenzie and Yoshida. 2009.
198 Björk, 2008.

Seagrass leaves and shoots harbor epiphytic algae and animals, like sea squirts, which serve as the base of food sources for a hierarchy of larger animals, such as fish, sea birds, shrimps, crabs, lobsters, *dugongs*, and sea turtles.

Their foliage also slows down water currents and traps sediments, thus, improving nearshore water clarity, and protecting adjacent coral reefs. Their roots and rhizomes are important for oxygenating and stabilising bottom sediments and preventing erosion.

Table 13.3: Number of Seagrass Species and Extent of Known Meadows in Southeast Asia.

Country	No. of species/ province	No. of species/ ecoregion	Seagrass area (km^2)
Bay of Bengal	**10**		
Northern Bay of Bengals (20108)		10	0.7
Andaman	**13**		
Andaman and Nicobar Islands (20109)		9	8.3
Andaman Sea Coral Coast (20110)		11	58.2
Western Sumatra (20111)		9	ND
South China Sea	**8**		
Gulf of Tonkin (20112)		5	36.9
South China Sea Oceanic Islands (20114)		4	ND
Sunda Shelf	**15**		
Gulf of Thailand (20115)		12	519.4
Southern Viet Nam (20116)		12	19.9
Sunda Shelf/Java Sea (20117)		13	5.2
Malacca Strait (20118)		14	21.7
Java Transitional	**12**		
Southern Java (20119)		12	134.4
Cocos-Keeling/Christmas Island (20120)		3	26.0
Western Coral Triangle	**15**		
Palawan/North Borneo (20126)		12	20,115.3
Eastern Philippines (20127)		11	7,158.9
Sulawesi Sea/Makassar Strait (20128)		13	0.9
Halmahera (20129)		5	402.6
Papua (20130)		8	5.3
Banda Sea (20131)		12	8,246.2
Lesse Sunda (20132)		13	2.7
Northeast Sulawesi (20133)		5	ND
Sahul Shelf	**7**		
Arafura Sea (20139)		7	ND

Source: Fortes et al., 2018.

The carbon storage capacity of seagrass has been recognized since the early 1980s (e.g., Smith, 1981) but interest has recently intensified with the recognition of blue carbon ecosystems and their potential to contribute to climate change mitigation. Seagrass ecosystems have been estimated to bury 27–44 Tg organic carbon (C_{org}) year^{-1} globally, accounting for 10–18 percent of the total carbon burial in the oceans, and have soil C_{org} stocks comparable to those of temperate and tropical forests, mangroves, and tidal marshes.[199]

While there is considerable interest in bringing seagrasses and other blue carbon ecosystems into national accounting and mitigation frameworks, there is also significant interest at a more local scale, with local or regional governments, or even private companies, often exploring the potential to become carbon neutral or offset their carbon emissions.[200] The current attention on payment-for-ecosystem services and carbon trading also provides the opportunity to avoid or mitigate CO_2 emissions through the restoration and conservation of seagrass beds, which rank among the most endangered habitats in terms of global loss rates.

Box 13.1. Seagrass Knowledge Gaps

There has been a trend to estimate the organic carbon (C_{org}) storage potential of seagrass from a limited dataset. There are biotic and abiotic factors, which influence seagrass soil C_{org} storage in different locations. Seagrasses comprise a wide variety of species across a range of depositional environments (Carruthers *et al*., 2007), and the variability in the sedimentary C_{org} stocks among seagrass habitats had been found to be high—up to 18-fold (Lavery *et al*., 2013).

Further studies that expand the current knowledge on geomorphological and biological factors driving C_{org} storage are needed order to improve existing estimates of C_{org} storage in seagrass ecosystems (Serrano *et al*., 2016; Gullström *et al*., 2018; Mazarrasa *et al*., 2018). Estimates of C_{org} storage by seagrass meadows should consider inter-habitat variability to understand their potential to sequester CO_2 and derive robust global and regional estimates of blue carbon storage.

In Southeast Asia, regional research output has increased in the last two decades, with a trend towards more experimental, rather than descriptive research. However, there are knowledge gaps in socio-cultural-economic themed research, despite growing awareness of the importance of seagrass-human relationships in this region.

Source: Bedulli et al., 2020; Fortes et al., 2018.

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199 Duarte *et al*., 2005; Fourqurean *et al*., 2012.
200 Gössling, 2009.

Pressures

As natural inhabitants of coastal areas, seagrasses exist in proximity to areas of human habitation and are thus exposed to human-based activities. The causes of seagrass loss in Southeast Asia have been documented in two other reviews,[201] and these threats, and their associated challenges, still remain relevant today. Bottom-trawling, shrimp farming, extensive coastline destruction and modification, decline in coastal water quality, and human-induced development have endangered seagrass beds in Southeast Asia. Major issues[202] that may harm seagrasses include:

- warm water discharges from power facilities
- sediments from land-based activities like mining
- nitrogen loading from agricultural runoff, untreated municipal wastewater, and sewage from treatment plants and tanker terminals
- coastal development, including recreation facilities, marinas and coastal roads
- bottom trawling, use of push nets in shallow areas, and other destructive fishing practices
- extensive shrimp farming and reduced water quality from shrimp pond discharge
- floods and typhoons
- rising sea temperatures associated with climate change as a probable cause of the scorching or obliteration of seagrasses where its thermal limits are reached.

Increased nitrogen loading in coastal waters stimulates outbreaks of epiphytic algae that could outcompete seagrasses for available light, leading to reductions in seagrass productivity and substantial seagrass losses.[203] Macroalgal blooms are produced by nutrient enrichment of estuaries in which the sea floor lies within the photic zone.[204] In addition to light reductions by sedimentation and eutrophication, climate change may also reduce light by shifting weather patterns to cause increased cloudiness or by increased water depth caused by sea level rise.[205]

There are also negative impacts from tourism. In areas frequently visited by untrained and inadequately informed snorkelers, seagrasses were sparser, shorter, grew more slowly, and had more epiphytes compared to virgin areas.[206] These stresses were associated with sediment re-suspension and the relatively lower presence of epiphyte consumers in these areas.

As early as 1983, recommendations have already been made that seagrasses must be better understood, mapped and assessed of value before actions that destroy or degrade them are allowed to continue.[207] The high vulnerability of seagrasses to physical damage and pollutive substances must be periodically kept in check to maintain the health of seagrass ecosystems and the health of organisms that are dependent on it.

201 Fortes, 1995; Kirkman and Kirkman, 2002.
202 Menez *et al*., 1983; CRC Reef Research Centre, 2004.
203 Bertelli *et al*., 2021; Williams and Ruckelshaus, 1993; Short *et al*., 1995; Valiela *et al*., 1997; Brun *et al*., 2006.
204 Valiela *et al*., 1997.
205 Björk *et al*., 2008.
206 Herrera-Silveira *et al*., 2009.
207 Menez *et al*., 1983.

Obstacles to advancing seagrass research, knowledge, and conservation are rooted in either lack of expertise and training or the failure of effective management and policies. Fortes et al proposed a roadmap for seagrass conservation, with suggested solutions, including (1) encouraging collaboration between research institutions and scientists in the region to build capacity and share knowledge; (2) engaging with policymakers and governments to encourage science-based policies; and (3) engaging with communities to raise awareness and foster stewardship of seagrass in the region.[208] Furthermore, according to Fortes *et al*.: "Trajectories toward seagrass loss can be reversed if and when all concerned stakeholders contribute positively to the effort in reversing current coastal ecosystem degradation trends. In order to sustain the benefits that we all derive from these natural assets, substantial commitments and investments must collectively be made by communities, scientists, local governments, national government agencies, and assisting organizations to effect a change from the current self-destructive course to one of conservation and sustainable use. Indeed, a transdisciplinary approach is required, with each proposed step undertaken in a holistic manner and not separately or compartmentalized. There is a great opportunity and compelling grounds for regional collaboration and cooperation to tackle the issue of seagrass conservation. It would be a tragedy to let it slip."

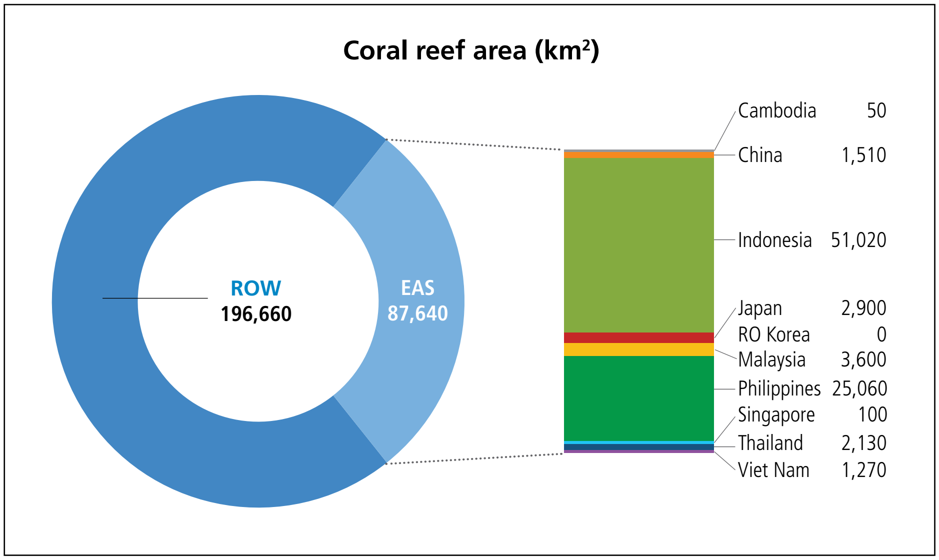
13.1.4 Coral Reefs: The Underwater Cities

Coral reefs are the most diverse of all marine ecosystems. They teem with life, with perhaps one-quarter of all ocean species depending on the reefs for food and shelter.[209] Dynamic underwater coral cities support up to 800 different species of hard coral, are home to more than 25 percent of all marine life, and reefs harbor the highest biodiversity of any of the world's ecosystems, making them one of the most biologically complex and valuable on the planet (GCRMN-ICRI, 2021). Coral reefs worldwide cover 0.2 percent of the world's oceans, yet they are exceptionally valuable in terms of the ecosystem services they deliver. The reefs provide food, livelihoods, and economic opportunity to people in more than 100 countries around the world. Millions more benefit from their wealth of treasures. through recreation, shoreline protection, and other ecosystem services. Around 45 percent of the world's coral reefs are found in the EAS region (**Figure 13.6**).

Koh Tang coral reef in Cambodia *(Photo courtesy of Scuba Nation)*

[208] Fortes *et al*., 2018.
[209] Smithsonian. 2018. Corals and Coral Reefs. (https://ocean.si.edu/ocean-life/invertebrates/corals-and-coral-reefs)

Figure 13.6: Area of Coral Reefs in the EAS Region.



Source: World Bank, 2017.

Pressures

Coral reefs play a critical role in the broader coastal and marine ecosystem, yet they are among the most threatened ecosystems on Earth, largely due to unprecedented global warming and climate changes, combined with growing local pressures. Despite their importance, coral reefs are facing significant challenges from human activities, especially from pollution, over-harvesting, destructive fishing, and physical destruction. Coral reefs are threatened by warming temperatures and ocean acidification. Anthropogenic greenhouse gas emissions have caused an increase in global surface temperature of approximately 1°C since pre-industrial times. This has led to unprecedented mass coral bleaching events. Even lower GHG emission scenarios (such as Representative Concentration Pathway RCP 4.5) are likely drive the elimination of most warm-water coral reefs by 2040–2050.[210] Measures, such as addressing local pollution and destructive fishing practices, cannot save coral reefs without stabilized GHG emissions.

Between 2009 and 2018, the continuous rise in sea temperature cost the world 14 percent of its coral reefs.[211]

[210] Hoegh-Guldberg *et al.*, 2017.

[211] Global Coral Reef Monitoring Network (GCRMN) - International Coral Reef Initiative (ICRI), 2021. Status of the Coral Reefs of the World: 2020.

Box 13.2. Status of Coral Reefs of the World: 2020

The key findings of this report are:

- Large scale coral bleaching events are the greatest disturbance to the world's coral reefs. The 1998 event alone killed 8 percent of the world's coral reefs.
- Subsequent disturbance events, occurring between 2009 and 2018, killed 14 percent of the world's coral.
- There was 20 percent more algae on the world's coral reefs in 2019 than in 2010. Increases in the amount of algae, a globally recognised indicator of stress on coral reefs, were associated with declines in the amount of hard coral.
- Declines in global coral cover were associated with periods of either rapid increase in sea surface temperature (SST) anomaly or sustained high SST anomaly.
- Since 2010, almost all regions exhibited a decline in average coral cover. Projections of increased SSTs in the future suggest coral reefs will experience further declines in the coming decades.
- Increases in global average coral cover between 2002 and 2009, and in 2019, suggest that many of the world's coral reefs remain resilient and can recover if conditions permit.
- High coral cover and diversity may confer a degree of natural resistance to elevated SSTs. Coral reefs in the East Asian Seas region, which includes the Coral Triangle and 30 percent of the world's coral reefs have, on average, more coral in 2019 than they did in 1983, despite being affected by large scale coral bleaching events during the last decade.
- Reducing local pressures on coral reefs in order to maintain their resilience will be critical while global threats posed by climate change are addressed.
- Monitoring data collected in the field are essential to understand the status of, and trends in, coral reef condition. Ongoing investment in the development of methodological approaches, new technologies, capability and capacity that expands geographic coverage and enhances the quality, accessibility and interoperability of data is essential.

Source: Global Coral Reef Monitoring Network (GCRMN) - International Coral Reef Initiative, 2021 (ICRI). Executive Summary: Status of the World's Coral Reefs, 2020.

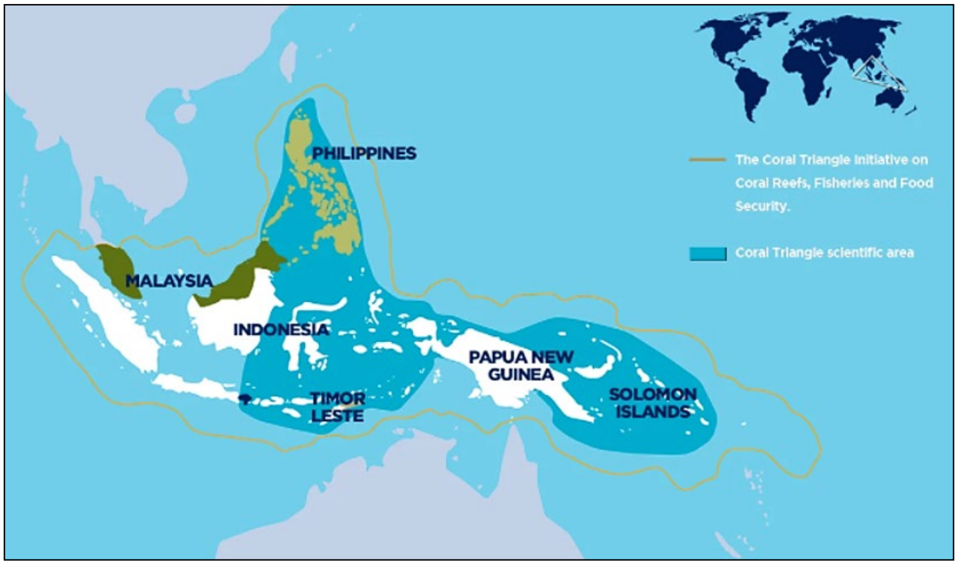
The economics of coral reefs: Why protection makes sense[212]

The Coral Triangle is one of the most highly biodiverse and ecologically important coral reef regions in the world, covering 1.6 percent of the planet's oceanic area, but containing 76 percent

[212] This section is from UN Environment, ISU, ICRI and Trucost, 2018.

of all known coral species and 37 percent of all reef fish species (WWF, 2017a). The Coral Triangle spans six countries (Indonesia, the Philippines, Malaysia, Papua New Guinea, Solomon Islands, and Timor-Leste, with the largest area falling within Indonesian territorial waters (**Figure 13.7**).

Figure 13.7: The Coral Triangle.



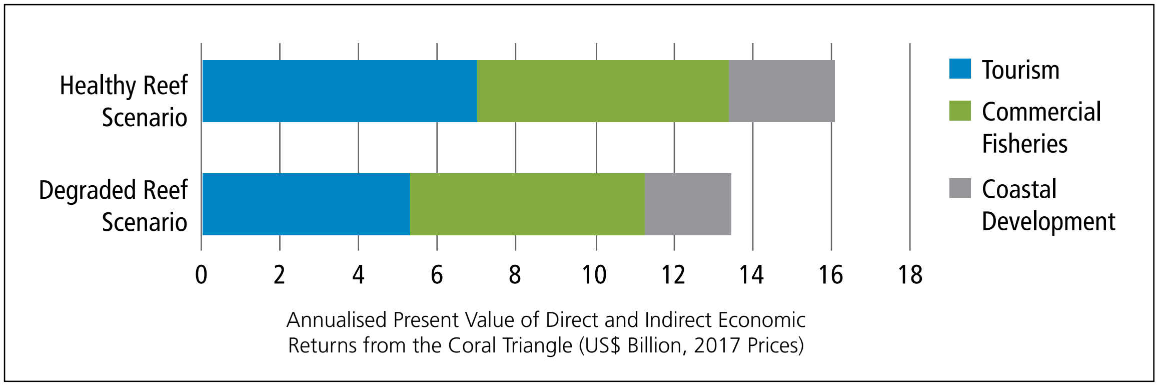
Source: WWF.

Initiated by the Prince of Wales's International Sustainability Unit (ISU) and United Nations Environment Programme (UNEP) and implemented in collaboration with Trucost and the International Coral Reef Initiative (ICRI), the study, *The Coral Reef Economy*, was done to analyse the value, costs and benefits and financial flows of the coral reef-dependent economy. The four strategic interventions studied are: (1) no-take MPAs; (2) constructed wetlands for enhanced wastewater management; (3) afforestation for erosion management; and (4) vegetative filter strips to reduce erosion on cropland. The study showed that interventions targeting sustainable fisheries, wastewater and erosion management could have positive impacts on the health of coral reefs and the reef-dependent economy. In the Coral Triangle, the interventions could close 70 percent of the gap between the estimated value derived from a degraded and a healthy reef by 2030.

The results of this study underscore that achieving improvements in coral reef health and unlocking major financial gains could be within reach. By quantifying the value of a healthy coral reef across three key sectors (tourism, commercial fisheries, and coastal development), the study highlights the strong business case to be made for both the private and public sectors to invest more in the protection, preservation, and enhancement of coral reef health. The key findings of the UNEP, ISU, ICRI and Trucost 2018 study are:

Coral Reefs Underpin Significant Economic Value for the Private Sector. The private sector economic value of coral reefs across the tourism, commercial fisheries and coastal development sectors is linked to their health. Today, their economic value to these three sectors equals US$ 13.9 billion per annum in the Coral Triangle. If reefs continue to decline, their per annum value could fall by US$ 2.2 billion in the Coral Triangle by 2030 (**Figure 13.8**).

Figure 13.8: Economic Returns from the Coral Triangle under Two Scenarios.

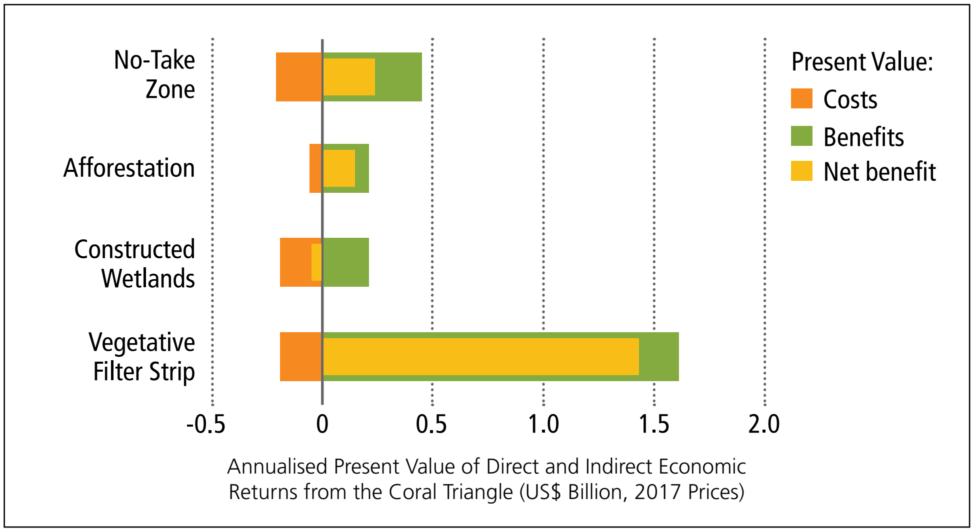


Source: UN Environment, ISU, ICRI and Trucost, 2018.

The Value of Future Healthy Coral Reefs is High. A shift toward a healthy state by 2030 could unlock an additional an additional US$ 37 billion (or US$ 2.6 billion per annum) in Indonesia. These potential returns highlight the financial business case for the private sector, along with governments and NGOs, to invest in coral reef health. Innovative and sustainable financing mechanisms will be essential to ensure investment flows.

Financial Return on Investment. A range of policies and interventions that could produce financial net benefits are available to governments and the private sector. The potential return on investment is 9:1 for better erosion management on agricultural land in Indonesia. **Figure 13.9** shows the estimated net benefits of interventions to ensure healthy reefs in the Coral Triangle.

Figure 13.9: Net Benefits of Coral Reef Interventions in the Coral Triangle.



Source: UN Environment, ISU, ICRI and Trucost, 2018.

Societal Co-Benefits of Healthy Coral Reefs Could Exceed Private Gains. The societal benefits of ecosystem restoration could be even greater than the financial gains of the private sector. For example, reducing the discharge of untreated municipal wastewater into coastal environments can create health benefits. Erosion management may reduce agricultural soil loss, while coastal afforestation can support sustainable forestry and increase carbon capture. The expansion of no-take zones promotes sustainable fisheries by preserving fish stocks and diversity. The results of this study should therefore not be taken as a reflection of the total value of coral reefs, but as one component of the broader economic, social and environmental benefits of protecting coral reef assets.

Interventions to Protect Coral Reefs Contribute to the Sustainable Development Goals. Action to enhance the health of coral reefs will help deliver the SDGs. The four interventions analysed all directly deliver on SDG 14 to conserve and sustainably use the oceans, seas and marine resource, while also contributing to SDG 6 on ensuring water and sanitation for all, and SDG 15 on the sustainable use of terrestrial ecosystems.

Climate Change Poses Significant Risk and Adds Uncertainty. Efforts to enhance coral reef health must be considered within the longer-term context of climate change, which presents an existential threat to many reefs. Even if the objectives of the Paris Agreement are achieved, reports warn that up to 90 percent of all coral reefs could be lost by 2050. Acting on local threats (including overfishing, erosion, and pollution) in order to maximise reef resilience may help moderate impacts, but climate change effects, including ocean warming and altered cyclone and rainfall patterns, add uncertainty to the analysis presented in this report.

Tubbataha Reefs *(Photo by Tet Lara, Marine Conservation Institute)*

Box 13.3. The Coral Triangle: The World's Center of Marine Biodiversity

The **Coral Triangle** is the epicenter for marine biodiversity – the engine room of the marine world. The Coral Triangle is a geographical term so named as it refers to a roughly triangular area of the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste. It is one of the three **mega ecological complexes** on our planet together with the *Congo basin* and the *Amazon rainforest*. The biological and environmental diversity is driven by the volcanically active and complex geology of the so called 'Ring of Fire'. Habitats range from underwater slopes of volcanic black sand to extensive coral reefs in atolls and vast calderas. The Coral Triangle is also called the "Amazon of the seas" and covers 5.7 million km^2 of ocean waters.

The Coral Triangle is home to one-third of the world's coral reefs. Within its boundaries are over 600 species of reef-building corals, which are vital to the future health of coral reefs and their residents. As a gauge to its diversity, the whole of the Caribbean has just 60 species of coral, and the Great Barrier Reef has 411 types of hard coral and more than 1,500 species of fish.

While only covering 1.6% of the planet's oceanic area, the reefs and their surrounding waters support:

- 76% of all known coral species
- over 3000 different species of fish
- 37% of world's coral reef fish species; 56% of the Indo-Pacific coral reef fishes
- 6 of the world's 7 turtle species, providing nesting grounds for five of these species
- 75% of known mollusks (such as octopus and squid)
- 22 species of dolphins
- at least 9 species of whales
- the endangered dugong
- whale sharks and manta rays, which are attracted to the triangle's abundant plankton
- the *coelacanth*, an ancient fish that pre-dates even the dinosaurs

The Coral Triangle is not only special for its corals. It also has the greatest extent of mangrove forests in the world. **75% of the world's mangrove species** are found in the triangle, along with **45% of seagrass species**. Both mangroves and seagrass are also vital habitats for turtles, dugongs, and countless juvenile marine species. At least 97 species of Indonesian reef fish and 50 species of Philippine reef fish are found nowhere else on Earth. The value of those species to their specific habitats is, to some degree, incalculable, because their specific evolutionary qualities and habits cannot be replaced.

Box 13.3. The Coral Triangle: The World's Center of Marine Biodiversity (cont.)

These reefs, seagrass, and mangroves sustain the lives of over 130 million people, who depend on healthy seas to make a living. About $3 billion in fisheries exports and another $3 billion in coastal tourism revenues are derived as annual foreign exchange income in the region.[213] These ecosystems support food security and protect coastal communities from storms and tsunamis. The coastal resources are the foundation for traditional cultures and sustain social fabric in many of the region's islands.

How did the Coral Triangle become a biodiversity hotspot?

Throughout its history, while other marine habitats have been frozen in ice during ice ages or left high and dry by falling sea levels, this area of the world remained mostly underwater. As a result, marine life has been allowed to evolve unhindered. Moreover, while other areas of the world drifted from the equator to temperate and polar regions because of plate tectonics, this area remained near the tropics in warm, clear water, which provides the perfect environment for coral reefs – the most productive and diverse of all habitats on earth. This continued stability and ideal conditions over millions of years has created a biological beauty.

The center of the center

Raja Ampat in Indonesia holds the title of the world's most diverse marine habitat—the bull's eye in the Coral Triangle. This group of islands, consisting of four main islands, around 1,500 smaller islets and 2,500 reefs, can be found on the western tip of Western Papua, formerly known as Irian Jaya. Aptly, the translation of Raja Ampat is 'four kings', a name given to the area when it was granted to four kings by a sultan of the famed Spice Islands (Mollucas) many centuries ago.

This relatively small, remote area in the Halmahera Sea has 600 coral species, 700 mollusks and more than 1,200 species of fish. Nutrient-rich currents feed the reefs and its inhabitants, which have remained relatively free from human interference due to their remote location. As a result, the numbers and variety of species is simply bewildering – a true king of kings.

The Philippines, which is at the apex of the Coral Triangle, is home to the **Tubbataha Reef National Park**, the only coral reef site in this region that has been declared as a UNESCO World Heritage Site. The Verde Island Passage, also in the Philippines, is the "center of the center of marine shorefish biodiversity."[214]

[213] Coral Triangle Knowledge Network.
[214] Carpenter and Springer, 2005.

Box 13.3. The Coral Triangle: The World's Center of Marine Biodiversity (cont.)

Pressures and threats

The Coral Triangle is brimming with marine life, but it is also straining to support one of the highest human population densities in the world. It sits at the crossroads of rapidly growing economies and trade.

- Poor management of marine resources in the Coral Triangle is driven by limited knowledge of value of sustainable resource use, high levels of poverty, and poor collaboration among key stakeholders, including the private sector and communities.
- Marine resources are being depleted at an unsustainable rate to supply growing seafood markets within the Asia-Pacific region and beyond.
- Overfishing, destructive fishing methods, and nonselective fishing gear have destroyed large sections of coral reefs and depleted fish populations. This trend is made worse by the practice of targeting juveniles and fish spawning aggregations.
- The unintentional harvesting of non-target species in fisheries – "bycatch" – is seriously endangering marine species, such as sea turtles and dolphins.
- More than 75 percent of the world's resource-intensive aquaculture industry is centered in the Asia-Pacific region, particularly in the Philippines and Indonesia, and increasingly Malaysia.
- Unregulated coastal developments, pollution from land- and sea-based sources, and sedimentation pose threats to habitats and marine life. Marine plastic debris harm a vast array of marine animals like the sea turtles and filter feeders.
- Rising, warming and acidifying seas due to climate change affect marine biodiversity and the lives of those who depend on the reefs for food, income, and resiliency. Mass coral bleaching threatens to degrade the coral reefs.

Reversing the tide

To maintain the health and productivity of the Coral Triangle, **the region must be managed as a single, large-scale system—biological, social, and economic**. Stronger political will and collaborative action among the countries within the Coral Triangle are needed to conserve marine biodiversity, stop habitat destruction, control pollution, end IUU fishing, and effectively manage their marine resources.

Sources: Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF) - www.uscti.org;
WWF (https://wwf.panda.org/wwf_news/?106580/The-Coral-Triangle-the-centre-of-marine-biodiversity);
Marine Conservation Institute (https://marine-conservation.org/on-the-tide/coral-triangle-10-times-as-biodiverse/)

Marine turtle on seagrass meadow. *(Photo by TEI)*

13.2 On the Brink: Rare, Threatened, and Endangered Species

The EAS Region is home to some of the most diverse habitats in the world, both above and below the water, but it is estimated that more than one in three species are endangered, and this figure is rising alarmingly fast. There is lower awareness of the threats to marine species because marine animals are not as visible as animals on land. However, marine creatures are equally, if not more, vulnerable to consequences of human activities. Underwater, a whole range of stresses and threats are putting marine life under immense pressure.

Populations of many species are decreasing at an unsustainable rate, and the number of species listed as endangered are on the rise. Whales, dolphins, turtles, and dugongs are often hit by boats and caught in fishing gear. Marine turtles that lay their eggs on land often lose their nurseries due to coastal development. Many marine species live in specific habitats while others require protection across their migration routes and breeding and feeding grounds that cover vast areas, including areas beyond national jurisdiction (ABNJ).

Intense pressures from population and economic growth are leading to over-fishing, pollution, destruction of crucial habitats, spread of disease, rising sea temperatures, and ocean acidification. Recovery from these problems is rarely straightforward.

Box 13.4. Rare, threatened, and endangered aquatic species

Whales. In total, there are around 40 species of whales, many of which pass through the tropics on their epic migrations. Eleven species are currently listed as **endangered**. Many are **vulnerable** as they are yet to recover from commercial whaling, which drove many species near to extinction. Commercial whaling was banned in the middle of the last century, but whales are still struggling. Modern threats to their survival include: (a) capture in *drift nets*, officially banned in 1992, but still used in certain places; (b) garbage, plastic litter, and chemical pollution that enter the whale's system and affect their health; and (c) increased boat traffic. Many whales are also being killed annually in the name of 'scientific research'.

Dolphins. Closely related to whales, the dolphin group also includes porpoises and the misleadingly named killer whale and pilot whale. Of all the dolphin family, the river dolphins are most under threat. River dolphins are less well known and much rarer than their marine counterparts. Globally, there are seven (7) species of river dolphins, three (3) of which are found in Asia: the Irrawaddy dolphin, the finless porpoise, and the Yangtze River dolphin, or *Baiji*.

The Irrawaddy dolphin is unique as it can be found in both fresh and saltwater. Tiny freshwater populations exist in four rivers in Asia, plus in a lake in Thailand. They are listed as **Critically Endangered**.

The plight of the *Baiji* is an international tragedy. Only found in the Yangtze River in China, it was declared functionally **extinct** in 2008.

Finless porpoises (*Neophocaena asiaeorientalis asiaeorientalis*) are the only freshwater porpoise. They can be found near coastal waters around the region and in the Yangtze River in China. They are classified as **critically endangered**. The main threats are fishing, which accidentally catch and kill the dolphins, pollution, and habitat degradation. Due to what happened to the Baiji in the Yangtze River, more conservation efforts are being done to save the Yangtze finless porpoises.

Dugong. Dugongs are closely related to manatees and are distant relatives of elephants. They feed solely on seagrass. They are hunted by people for their meat, oil, skin, bones, and teeth. They have even been hunted for their tears, which were thought to have medicinal properties. The largest populations are in Western Australia and Papua New Guinea, with smaller populations in Thailand, Cambodia, Malaysia, and the Philippines. Additional threats come from habitat loss, pollution, and boat traffic, as they need to surface to breathe every six minutes. As female dugongs only give birth to a handful of young in the lives, they

Box 13.4. Rare, threatened, and endangered aquatic species (cont.)

are a species that struggles to rebound from any loss of population. They are considered '**Vulnerable to Extinction**' throughout the region.

Sharks. Sharks have inhabited our planet and controlled the food chain for more than 400 million years. Currently, there are 400 species of sharks in the world. Over half of them are now considered **Endangered** or **Vulnerable**. It is estimated that, since 1970, the numbers of some shark species have declined by 95 percent or more. Some hammerhead sharks are thought to have declined by more than 99 percent. While conservation efforts focused on more 'cuddly' creatures, sharks have slipped through conservation's net. Unfortunately, millions of them have ended up in fisherfolk's nets, supplying the ever-growing demand for shark fin soup in China. Similar to the Napoleon Wrasse, shark fin soup is considered a delicacy in China, and the growing wealth of this country means that more and more people can now afford it. Once the shark's fins are removed, they are simply tossed back into the ocean to die. Only now, when they are well on their way to being wiped out, their importance to the entire marine food chain and therefore to humans is beginning to be appreciated. The decline in numbers is so alarming that, unless very urgent action is taken, 400 million years of evolution may be destroyed in the blink of an eye.

Marine Turtles. Turtles have survived on this planet since the days of the dinosaurs, around 100 million years ago. There are seven species of marine turtles in the world, of which six species can be found in the Asia-Pacific region. Once plentiful, five of these species are now listed as **endangered**, with the hawksbill and leatherback turtles listed as **Critically Endangered**. The sixth species, the *flatback turtle*, cannot be listed because there is not enough information about it. While female turtles lay hundreds of eggs, even under natural conditions only a handful ever survive, and they take decades to reach sexual maturity and reproduce. The main threats to marine turtles are: (a) demand for their meat and beautiful shells; (b) reduction of their habitats, especially the beaches they need to lay their eggs; (c) irresponsible fishing practices that accidentally catch turtles - known as 'by-catch'; (d) increasing boat traffic; and (e) pollution, such as plastic bags that they mistake for food, and chemical pollution that affects their health.

Napoleon Wrasse. The Napoleon Wrasse is also known as Humphead Wrasse and Maori Wrasse. They are one of the largest fish found in the coral reefs, reaching up to 2m in length. Their reproductive behavior is also curious, with individuals changing from female to male as they grow older. They are highly sought after as they are considered a high-class food, regal delicacy in some areas and, as wealth increases, they are sought by more and more people. They are slow to reproduce, which means populations will struggle to recover. Often, it is the

Box 13.4. Rare, threatened, and endangered aquatic species (cont.)

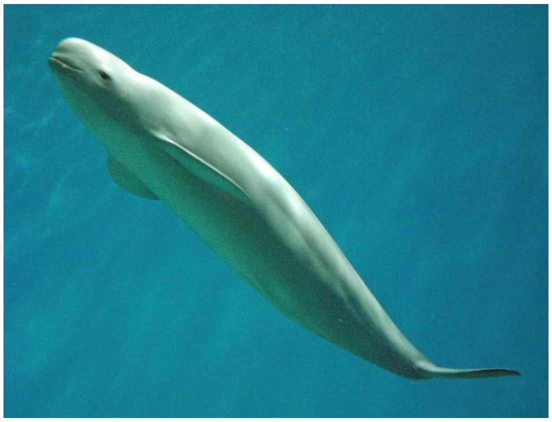
juveniles that are killed, making their future even bleaker. They are often caught by spear-fishing and cyanide fishing. They are now listed as **endangered**.

Seahorse. Seahorses are one of the most unique fish in the oceans. Not only is their appearance unique, but so is their behavior. Unlike other fish, it is the male seahorse, which gives birth to the young, not the female. These shy creatures were once common all around the world, now they are endangered. Before human intervention, they had almost no predators due to their excellent camouflage. Now, 24 million seahorses are taken from the oceans each year in an industry involving 77 different countries, to be used in traditional Chinese medicines, sold as souvenirs, or kept as pets. They have also suffered because of shrimp trawling, destructive fishing methods and pollution. There are 35 species of seahorse in the world, around 25 of which are found in tropical waters. Many of them are now listed as **endangered**.

Tuna. Tuna populations are facing collapse. Between 1960 and 2000, the global tuna industry doubled in size every 10 years, reaching a peak in 2004. Southeast Asia currently supplies half of the world's tuna, but demand is far exceeding supply, and stocks are declining at an alarming rate. Two of the key tuna species in danger are yellowfin and bigeye tuna. The demand for Tuna has led to huge amounts of illegal, unreported, and unregulated (IUU) fishing, on top of licensed fishing levels that are considered unsustainable. This huge amount of fishing is also having a big impact on many other species, both large and small, which are the 'by-catch' of the huge tuna fishing industry.

Source: CTI-CFF; IUCN; UNEP

Irrawaddy dolphins. *(This Photo by Unknown Author is licensed under CC BY SA)*



Finless porpoise. *(This Photo by Unknown Author is licensed under CC BY SA)*

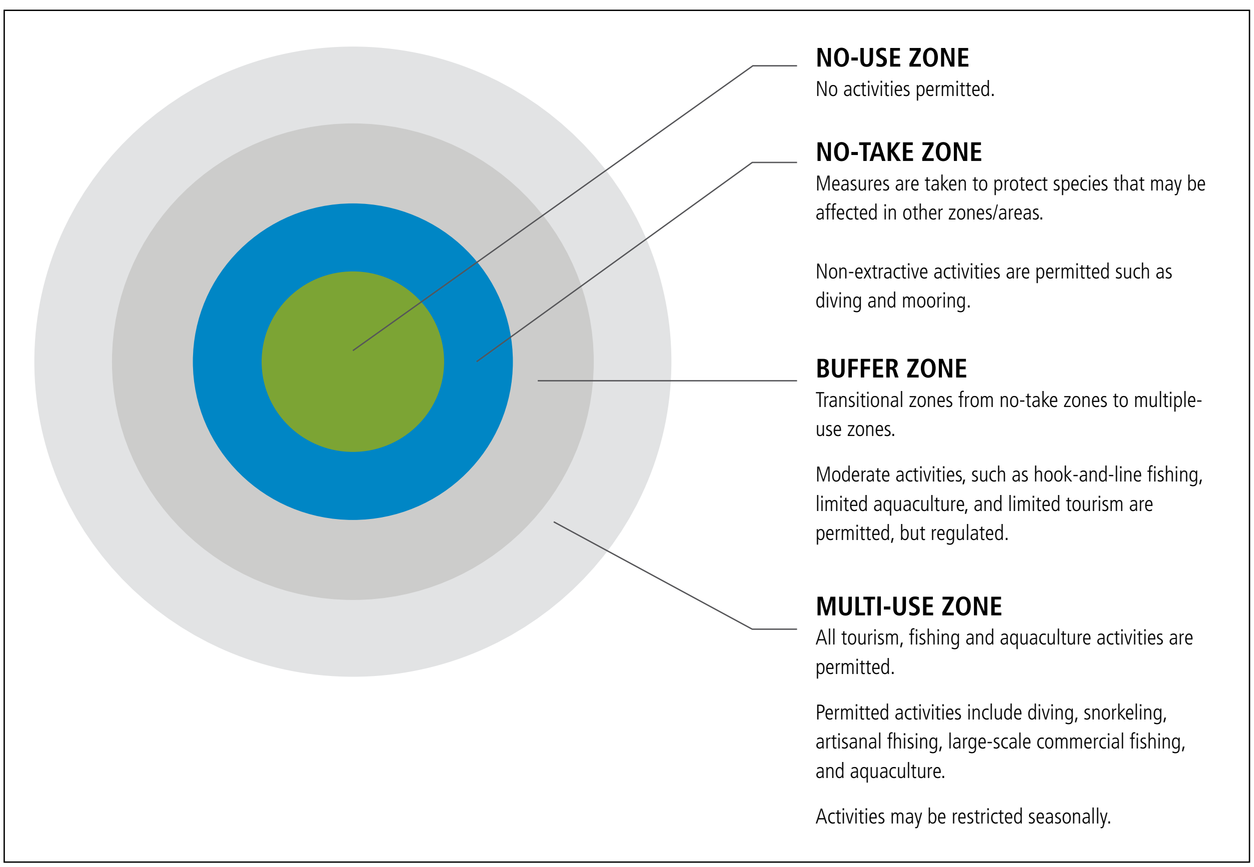
13.3 Undoing the Slide: Ecosystem Restoration, Protection and Sustainable Management

13.3.1 Marine Protected Areas

Marine Protected Areas (MPAs) are geographically defined areas in the ocean that are designated for conservation as part of an ecosystem-based management (EBM) approach to protecting marine resources. MPAs are demarcated by law and can include intertidal, sub-tidal, and pelagic environments. Within these environments, governance systems are implemented to protect the relevant body of water, bottom, marine and terrestrial flora and fauna, and notable historical and cultural features.

There are many different types of MPAs. Zoning within MPAs allow protection measures that range from multiple-use (i.e., allowing some types of fishing or certain recreational activities) to 'no-take' (i.e., no extractive activities, such as fishing, mining, drilling, are allowed) or even 'no use' areas (i.e., no activities are allowed). Some MPAs also restrict certain areas to one specific use (e.g., local fishing), depending on the unique features and overall needs of a particular area.

Figure 13.10: Zoning in MPAs.



Source: Marine Managed Areas: What Why, and Where, Science to Action.

What are the benefits of MPAs?

MPAs play a significant role in the blue economy, emphasizing ocean as natural capital. MPAs have been designated in many places in the EAS region, which can help protect and restore biodiversity, including threatened and endangered species, and their habitats.

Ecological impacts

MPAs offer protection to habitats, endangered species, and key biodiversity areas, act as carbon sink, and promote sustainable fisheries, tourism, and other ocean economic activities.

Establishing MPAs as part of ocean and fisheries management has already been shown to work, and displaced fishing effort is often offset by "spillover" of adult and larval target species from populations inside MPAs as they recover from fishing pressure.[215] Analysis of 124 temperate and tropical MPAs in 29 countries indicated large increases in biomass (+446%) and densities (+166%) of organisms inside no-take zones plus increases of individual size (+28%) and species richness (+21%) compared to non-protected areas.[216] One study in the Philippines saw a significant increase in fish density outside of an MPA between 9 and 11 years after the no-take area was established.[217]

MPAs and MPA networks in coastal habitats (mangroves, seagrasses, salt marshes) are carbon sinks. Their protected status can ensure that no new emissions arise from the loss and degradation of these habitats. Their restoration also stimulates new carbon sequestration.

Moreover, by providing protection from certain activities that create pressures on the marine environment, MPAs allow habitats and species to be more resilient and adapt to climate change.

Economic impacts

Economic benefits of MPAs include reconstituting ecosystem services, general resilience to system shocks, stabilization of fish population, more sustainable catch level, tourism and increased opportunities for job creation, and reducing risks from natural hazards.

Increasing global MPA coverage to 30 percent of the ocean would accrue economic benefits of US$ 490 billion to US$ 920 billion by 2050, and would create between 150,000 and 180,000 new jobs in MPA management.[218]

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[215] Ceccarelli DM and L Fernandes. 2017. MACBIO.
[216] Lester *et al.*, 2009.
[217] Russ and Alcala, 1996.
[218] Reuchlin-Hugenholtz and McKenzie, 2015.

Protecting breeding and nursery grounds within MPAs could increase the population of commercially viable species (e.g., finfish and shellfish).

MPAs that protect coastal habitats, such as mangroves, barrier islands, coral reefs, seagrass, and wetlands reduce human vulnerability in the face of climate change and provide the natural coastal protection infrastructure on which people rely.

Other effective area-based conservation measures (OECM)

Other effective area-based conservation measures (OECMs) are a conservation designation for areas that are achieving the effective in-situ conservation of biodiversity outside of protected areas.[219] In 2018, Parties to the Convention on Biological Diversity (CBD) agreed on guiding principles, common characteristics and criteria for the identification of OECMs (CBD Decision 14/8). OECM is defined by the CBD as:

> *A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values* (CBD, 2018).

What has been done?

In 2017, only 6.35 percent of the global ocean is protected, one third of the 232 marine ecoregions have at least 10 percent of their area protected, and just over 1.89 percent is covered by exclusively no-take MPAs in 2017.[220]

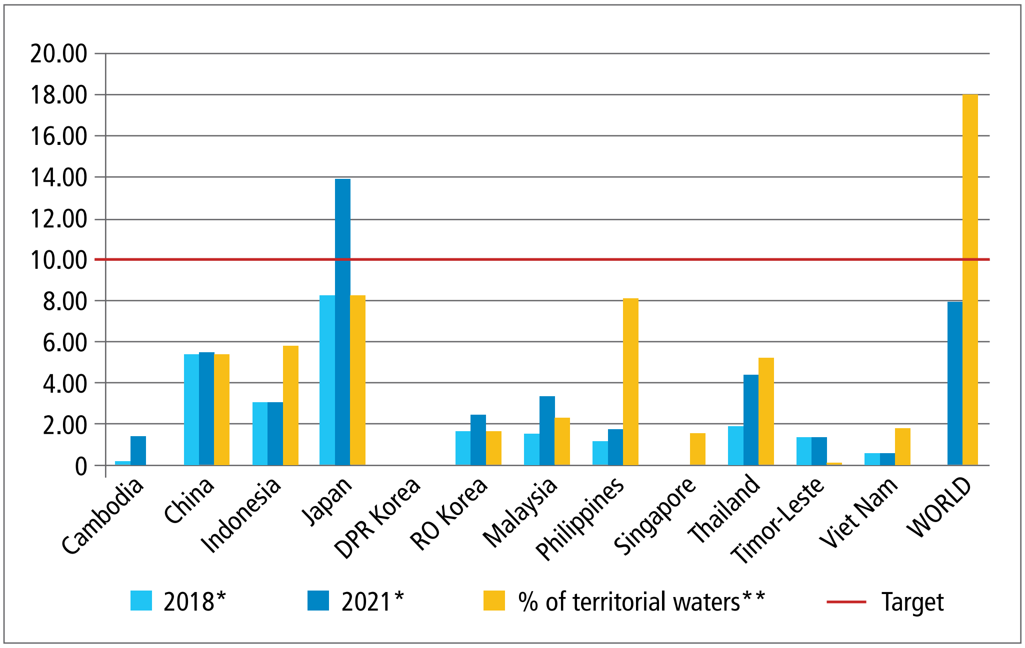
As of 2021, there are 17,852 MPAs, providing protection to 7.91 percent of the global ocean, and with the additional 192 OECMs, protection coverage increases to eight percent of the global ocean, falling short of the 10 percent target.[221] However, 18 percent of coastal and marine areas within national jurisdiction is covered by MPAs and OECMs in 2021 (**Figure 13.11**).

The world's system of protected areas and OECMs is also becoming more representative of the full range of ecosystems, with 47.4 percent of the 232 marine ecoregions meeting the 10 percent target; however, 15.5 percent of the world's marine ecoregions still lack any coverage at all.[222]

219 IUCN-World Commission on Protected Areas.
220 UNEP-WCMC and IUCN, 2017.
221 UNEP-WCMC, 2021.
222 UNEP-WCMC, 2021.

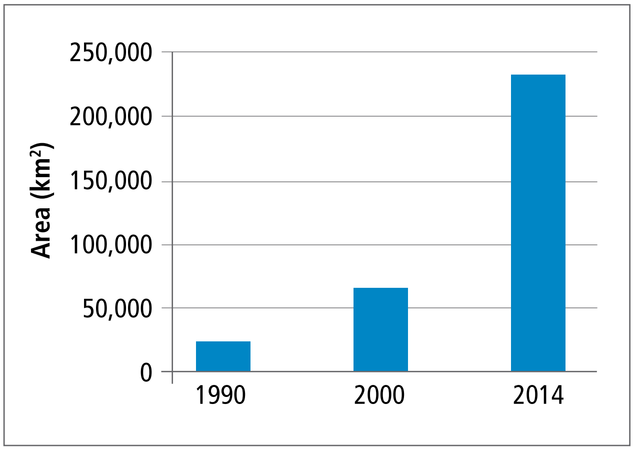
In the EAS Region, only Japan has exceeded the ten percent target, with 13.89 percent of its total coastal and marine area under MPA. Although much progress has been made in increasing coverage of MPAs in ASEAN countries (**Figure 13.12**), those MPAs in the ASEAN countries account for less than 10 percent of their respective territorial waters (**Figure 13.11**). This is far from the commitments made by countries in relation to the Aichi Biodiversity Target 11. Moreover, there are issues on the effectiveness of management of MPAs, locally managed marine areas (LMMAs), and LMEs. Most existing MPAs do not have enough human and financial resources to properly implement conservation and management measures, including monitoring, surveillance, and enforcement. Efforts should focus on both the quantity and quality of protected and conserved areas.

Figure 13.11: Percentage of Marine Water under Marine Protected Areas.



*Sources: *UNEP-WCMC 2021 (% of total coastal and marine area); **World Bank; NSOC Reports (% of territorial waters)*

Figure 13.12: MPAs in the ASEAN.



Source: ACB 2017.

What can be done?

More concerted regional and global action on targeting of **Key Biodiversity Areas** to come under protection, and country assessments of how their MPAs are designed, effectively and equitably managed and connected are still needed to meet the overall target and elements under Aichi Biodiversity Target 11 and SDG 14. Despite being acknowledged as crucial to conserving marine biodiversity, most of the countries have not established more MPAs.

Integrated Coastal Management (ICM) and tools, such as Marine Spatial Planning (MSP) and National Adaptation Plans, can be used by countries to improve the management of MPAs and help meet multiple objectives, including sustainable development, increased incomes from fisheries and tourism, biodiversity conservation, and climate change mitigation and adaptation.

Identification of OECMs also offers a significant opportunity to increase recognition and support for *de facto* effective long-term conservation that is taking place outside currently designated protected areas under a range of governance and management regimes, implemented by a diverse set of actors, including by Indigenous peoples and local communities, the private sector and government agencies.[223]

In LMMAs, recognition by communities of the need for establishing and managing protected areas is often triggered when fish and invertebrate stocks are seriously depleted. The main driver is a community desire to maintain or improve livelihoods, often related to perceived threats to food security or local economic revenue, compounded by threats from climate and environmental changes. Providing alternative livelihood programs for those who will be displaced and affected by no-take and regulated use zones is also essential to get the support of local communities, especially when the establishment of MPAs are introduced by the national/central government or by external groups. Increasing awareness about the role of habitats in fisheries as well as shoreline protection, carbon sequestration, and climate change mitigation has also increased the support for the establishment of MPAs.

Adaptation strategies, such as the National Adaptation Plans and National Plan of Action (NAPA), as well as mitigation efforts, such as REDD+ and NDCs under the Paris Agreement, provide opportunities to use MPAs as an implementation tool for ecosystem-based adaptation and mitigation. Climate finance mechanisms, such as the *Green Climate Fund* (GCF), offer support to enable developing countries to implement marine and coastal ecosystem-based adaptation and mitigation efforts, with a focus on biodiversity conservation and protected area management.

Linking fisheries, biodiversity and climate change, together with enhancing income and livelihood opportunities provide a stronger strategy to increase uptake of MPAs.

[223] IUCN – World Commission on Protected Areas, 2021.

13.3.2 Habitat Restoration

Although planting new trees can help, keeping intact wild areas are much better. The world needs to treat global warming and ecosystem and biodiversity loss as two parts of the same problem. Protecting, enhancing and restoring natural carbon sinks must become political priorities as costs of biodiversity loss and climate change are going up, and changing life as we know it. Restoration and reduction of threats can strengthen resilience into existing habitats by allowing the habitats and associated species to recover.

It should be noted that poor implementation of mangrove restoration efforts highlights the need for localized capacity building. Active replanting efforts by some local governments, communities and NGOs have gone wrong in some cases, wherein the incorrect type of mangrove was planted, or propagules were planted in the wrong time (high tide), wrong location, or in other habitats like seagrass beds and mudflats.

Country examples

Mangrove restoration projects in Thailand and the Philippines resulted in recovery of mangrove areas in these countries.

Thailand. Since 1996, the rate of mangrove encroachment has been gradually decreasing because of the raised awareness among all stakeholders on conservation and rehabilitation of mangrove areas. Mangrove forests increased from 1,675.8 km^2 in 1996 to 2,455.3 km^2 in 2014, about 1.5 times of that in 1996. The increase was mainly because there were a lot of mangrove planting activities carried out by government agencies, private sector, and NGOs.

Philippines. The *Philippine Biodiversity Strategy and Action Plan (PBSAP) 2015-2028* aims to restore or begin the initial state of restoration of one million ha of degraded ecosystems by 2028. Restoration projects for both terrestrial and aquatic ecosystems account for 47 percent of the total estimated cost of the PBSAP.

The coral restoration program focuses on both sexual (the use of coral egg and sperm in the formation of coral propagules) and asexual methods (the fragmentation method). This program stresses on the importance of public-private-academe partnership in the implementation of the restoration effort. Reproductive patterns of at least 10 coral species have been monitored – data that are fundamental for the creation of species-specific sexual propagation methods. Molecular genetics and the identification of susceptible and resilient species to the rise in sea surface temperature and eutrophication have also been done.

Coral gardening, on the other hand, was used in the reef restoration of 10 areas devastated by Typhoon Yolanda (Haiyan).

The *National Greening Program (NGP)* is one of the pioneering programs by the government on mangrove restoration. The NGP has restored 76,514 ha of mangrove areas, with 199,367,952 seedlings planted throughout the country in 2011-2016.

Mangrove restoration was also initiated under the *Philippine National Aquasilviculture Program* (PNAP) with 61 provinces all throughout the country, aimed to address issues on food security and climate change mitigation. Mangrove rehabilitation under the PNAP involved the coastal fisherfolk in the planting of 100 million propagules for the next 3-4 years.

China. China is identifying the ecological red line, establishing networks of marine reserves and MPAs, restricting sea reclamation, and conducting ecological remediation projects, including the "Developing mangrove forests in the south and Chinese tamarisk forests in the north", and "Blue Bay" as part of promoting the **blue carbon**.

Indonesia. Current efforts to restore natural resources and the environment have become a trend of private interest through community development programs and corporate social responsibility as well as one of the leading programs in several government agencies in recent years. One of the recovery efforts whose track record is significant is the **Coastal Recovery Program** through the rehabilitation of mangrove areas. In 2010-2013, mangrove rehabilitation in Indonesia has reached 35,103 ha spread over 34 provinces in Indonesia.

Based on some studies, an investment cost of IDR 175 million (US$ 13,000) is required to rehabilitate and protect 1 ha of mangrove forest in Sedari village of Kerawang Regency, and operational and maintenance cost, including breeding and planting, of IDR 35.69 million (US$ 2,640) every year. Using cost-benefit analysis, the net benefit of mangrove rehabilitation, was estimated to be around IDR 58.04 million, and a net benefit-cost ratio of 1.19, assuming management duration of 10 years and discount rate of 5 percent.[224] This shows that mangrove rehabilitation generates positive net benefits.

Japan. People in Okinawa, Japan have participated in the coral restoration project for over 15 years. According to Yoshimi Nagahama, Mayor of Onnason, Okinawa, over 25 thousand seedlings have grown and spread along the coast, and the grown coral have spawned.[225] Coral reef restoration activities involving school children were carried out throughout 2018 as part of the International Year of the Reef celebrations by the dive community of Okinawa with support from the PADI® Japan Project AWARE® Volunteer office in collaboration with National Geographic.

[224] PEMSEA and MOEF, 2019.
[225] PADI-AWARE Foundation. 2019. https://www.projectaware.org/news/coral-reef-restoration-okinawa.

Box 13.5. Coral Restoration and Conservation in Serangan Island, Denpasar City, Bali

Coral reefs take a long time to recolonize naturally, but recovery can be accelerated through coral transplantation techniques. All coral species can be transplanted similar to assisted vegetative propagation. Under intensive maintenance, transplantation of corals can effectively restore and rehabilitate reefs.

In 2003, a group of young coral miners became highly motivated to protect coral reefs after learning of reef conservation from environmental campaigns and organized themselves into the "Coastal Fishers Group of Karya Segara" (CFGKS). The environmental management program in Serangan Island was supported at all levels of government: from village level to Denpasar Municipal Government and Bali Provincial Government, and to national level, through the Ministry of Marine Affairs and Fisheries (MMAF). CFGKS also established partnership with the private sector, such as the PT Bali Tourism Development Center (BTDC), Nusa Dua and PT Indonesia Power, through their corporate social responsibility programs.

Starting in 2008, tourists were encouraged to participate in the restoration of coral reefs through the **coral adoption program**. Transplanting corals became a tourist attraction in the island along with other recreational activities. Tourists learn about marine conservation, at the same time choose tour packages that include transplanting corals, releasing seahorses, swimming, diving, and snorkelling. The seahorses come from the culture farm of the community group. Each tourist was charged a fee for each cutting of coral that she/he transplants, with the fee going to the host community. Experience showed that by participating in the program, tourists were able to identify themselves as part of the community; were proud to be counted as reef protectors and conservationists; and enjoyed benefits derived from the unique and valuable experience of their visit to the island. In 2011, CFGKS began to work with travel agents to bring more tourists to the island, thus contributing to the increasing revenues generated by ecotourism.

The ICM program facilitated the development of the fisher group by building a network of partners to sustain their conservation effort and develop ecotourism services in collaboration with tourism agencies. This complete turnaround saw the transformation of some community fishers from being reef destroyers to active conservation advocates. Their strong conviction on environmental conservation and leadership earned them the respect of the community, and recognition from the country when they received the "kalpataru" award in 2011 – Indonesia's highest award for environmental management programs. Serangan Island became a place of learning for many local governments, NGOs, community groups, and students from universities within and outside Indonesia.

Source: I Ketut Sudiarta. 2018.

Singapore. Initiated by Tropical Marine Science Institute (TMSI) in collaboration with MPA, the project focused on the development of protocols for both the relocation and restoration of coral reefs. With coral transplantation as the method adopted for the establishment of new reefs, while degraded reefs will be rehabilitated. The concepts and principles developed through the programme can be applied to support the sustainable development and management of coastal cities. The project has four strategic directions:

1. Optimize the methods for establishing coral nurseries and transplantation to augment growth and survival of the coral fragments.
2. Assess the suitability of coral species for rearing in the nurseries and for transplantation.
3. Engage volunteers in the coral rearing and restoration efforts and to examine the efficacy of citizen science in reef restoration.
4. Assess the changes in reef community assemblages following coral transplantation.

Results of the reef rehabilitation efforts and public outreach:

1. Reef rehabilitation effort
   (a) Restored a total of 300 m^2 of reefs through the projects (150 m^2 new reefs, 150 m^2 degraded reefs) using 420 nursery-reared corals. Of these, volunteers assisted with the rearing of 216 corals in the nursery in 2014, which were subsequently transplanted to Lazarus in 2015. Total estimated area transplanted restored by volunteers: 80 m^2. Total participants: 52 (25 in 2014, and 27 in 2015).

2. Discovery of uncommon coral species in Sultan Shoal:
   (a) Two colonies of *Echinopora horrida* were found on the Sultan Shoal reef, limited to a relatively small area. This species was not recorded in the 2009 coral survey, and museum specimens were last collected in 1980. Tissue has been collected for DNA barcoding.
   (b) Part of one colony was fragmented, and the fragments are currently reared in the coral nurseries for reintroduction to other reefs to ensure species survival.

13.3.3 Co-management

Collaborative management or co-management is a process-based management and governance approach to natural resource management. It is usually the ideal, that is, the cooperative sharing between community and government in the design, authority, responsibility, and benefits of natural resource management and biodiversity conservation projects. The close collaboration and coordination in the management of habitats, culturally important and endangered species, and protected areas means that the government together with the rural population living close to or in the protected area negotiate, **define and guarantee a fair sharing of management functions, rights and responsibilities**. Co-management arrangements differ from area to area.

Mangroves for the Future: Co-management in Viet Nam's national park

Xuan Thuy National Park is a coastal national park, and Viet Nam's first Ramsar site. Following a series of consultations led by the park's management board, a Women's Fishing Group was established to represent the interests of the nearly 500 women collectors of clams in the area. The women's group and the authorities then set about negotiating a co-management policy with regulations and licensing determining what can be collected, in which areas, at what times, and using what methods. A peer-based monitoring system was established to help park authorities regulate compliance.

The local government established a Livelihood Improvement Fund whereby women could take small loans to make opportunities to diversify the income base with the idea of reducing the amount of clams they need to collect in Xuan Thuy.

This co-management arrangement between the park authorities and the collectors established a win-win situation for both. For the collectors, they secured user rights to a critical resource and now actively participate in the co-management system. For park authorities, they mitigated a growing conflict situation, and now the collectors are an ally in the sustainable management of the area.

Co-management for coastal resource protection in Bali, Indonesia

As the management tasks were delegated to villagers and village government, the villagers of Jemluk developed their own management mechanism. Under the supervision of the Provincial Fisheries Service, Tourism Department and the local police station, villagers and the village government established co-management mechanism for coastal waters. A fisher association—Tunas Mekar Fisher Association (TMFA), whose members consist of fishers who also work in tourism, was established. The objective of the TMFA is to manage Jemluk waters as a source of people's livelihood. In addition to fishing, the TMFA members bring tourists for snorkelling and diving in both coral and artificial reefs. The TMFA has an executive board consisting of one coordinator, one secretary, and one treasurer. **Table 13.4** shows the basic rules or regulations initiated by the villagers for the purpose of managing Jemluk waters. The rules are applied to both members and non-members of the TMFA.

Table 13.4: Basic Co-management Rules on Utilization of Jemluk Coastal Areas.

Objective	To manage Jemluk waters as a source of people's livelihood rules
Rules	• Unlawful to dump garbage at sea.
	• Prohibition to extract corals, and catch ornamental fish.
	• Area under the co-management is the water from the coastline until 35m deep
	• The rules are stipulated by community convention under supervision of the Provincial Fisheries Service, Tourism Department and the local police.
Roles and responsibilities	• Monitoring of the rules and patrolling are performed by villagers.
	• Enforcement of the rules is under the auspices of the local police.
	• Users and beneficiaries

Under the coastal waters co-management measures, pressure on the resources seemed to be reduced. Artificial reefs were deployed by the local government and managed by fishers to help restore fish habitats. The fisherfolk are benefiting from the installation of artificial reefs by generating income through fishing and tourism activities. The construction of the artificial reefs made the resource more productive. The pristine condition of beaches was gradually regained. The new approach to resource management, based on village participation, has been effective. The artificial reefs, which were developed to replace destroyed coral reefs and provide fish habitats, have also functioned as fishing grounds for small-scale fishers, ecotourism and recreational areas, as well as the entry point for co-management.

13.3.4 Corporate Social Responsibility

Since many private sector actors in coastal areas are dependent on coastal resources for their business, the logic to engage the private sector speaks for itself. The Marriott company is an example of how a private sector entity can contribute to coastal conservation and integrate supporting local economies and livelihoods in coastal areas near the Marriott properties. The IUCN-Marriott partnership has 3 main components:

- *Mangrove restoration*: Marriot collects donations from hotel guests to support mangrove restoration in four target areas in Thailand. Seven hectares were reforested in 2016.
- *Sustainable seafood sourcing*: IUCN works with Marriot to identify and source sustainable seafood directly from local communities nearby their properties. For example, in 2016, two Marriot properties sourced more than USD45K in seafood from 40 families in 3 villages around the properties.
- *Sourcing of local products as gifts and souvenirs*. IUCN also works with Marriot to source local handicrafts to be used at Marriot properties. Four of their properties present welcome bracelets to their guests. In 2016, Marriot purchased USD 30K in bracelets from 26 families in a village near their Phuket property.

14 Ocean – Climate Nexus

"You cannot protect the oceans without solving climate change and you can't solve climate change without protecting the oceans."[226]
John Kerry (former US Secretary of State)

Key SDG targets:

- **SDG 14:**
  - **Target 14.2**: Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.
    - ◊ **Indicator 14.3.1**: Reduce ocean acidification. (This is the **average marine acidity** (pH) measured at agreed suite of representative sampling stations.)

- **SDG 13:**
  - **Target 13.1**: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
    - ◊ **Indicator 13.1.2**: Number of countries that adopt and implement **national disaster risk reduction strategies** in line with the Sendai Framework for Disaster Risk Reduction 2015–2030.
  - **Target 13.2**: Integrate climate change measures into national policies, strategies, and planning.
    - ◊ **Indicator 13.2.2**: **Total greenhouse gas emissions per year.**
  - **Target 13.3**: Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.
  - **Target 13.b**: Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth, and local and marginalized communities.

- **SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.**

- **SDG11: Make cities and human settlements inclusive, safe, resilient, and sustainable.**

[226] Special Guest Remarks at Ocean-Climate Ambition Summit 2021. (https://www.state.gov/special-guest-remarks-at-ocean-climate-ambition-summit/)

The role of the ocean in the climate system is increasingly being recognized. The earth's climate and the ocean are fundamentally linked in so many ways that are still not yet fully studied and have just started being an integral part of climate discussions. The ocean plays a key role as a climate regulator, in absorbing carbon, producing the oxygen we breath, and in buffering the damaging effects of climate change. Meanwhile, the human activities that cause climate change, predominantly GHG emissions, are also affecting the health of the ocean, making it increasingly warmer and causing ocean acidification, which can devastate coral reefs and change fish stocks. We are damaging the very system that is fundamental to our wellbeing. Together, the impact of acidification as well as the warming of the ocean and sea level rise can lead to various catastrophic consequences on the whole world. Climate change is a looming threat to the long-term social, geopolitical and economic stability of the EAS Region.

14.1 Risks from Natural Hazards and Climate Change

Long coastlines and heavily populated low-lying areas make the EAS region one of the world's most vulnerable to weather extremes and rising sea levels associated with the changing climate (**Table 14.1**). Typhoons and floods are becoming more intense and frequent as Southeast and East Asia bear the brunt of climate change.

- Heavier rainfall and more intense storms lead to flooding, damage to property, and more polluted runoff, while droughts result in water scarcity affecting drinking water supply and agricultural and industrial production.
- Warmer waters hold less dissolved oxygen, exacerbating dead zones, fish kills, and algal blooms.
- Temperature changes affect key species, impacting not only the species themselves but also the municipal and commercial fisheries that are integral to the region's economy and food security and nutrition. Warmer water temperatures have caused coral bleaching.
- Sea level rise threatens lives, livelihoods, property, and habitats in coastal communities and cities.

Understanding the breadth of physical hazards is only one element of a climate risk assessment. For the communities and private sector to build its resilience to climate change, and prepare disaster risk reduction and management measures, they need to take a three-dimensional approach to assessing risk.

1. **Hazard**: A "hazard" is a possible future occurrence of natural or human-induced physical events that may affect assets like infrastructure, resources, goods, or services.
2. **Exposure**: "Exposure" refers to the presence of elements—such as employees, communities, environmental resources and services, buildings, or transportation modes—in an area where hazards may occur.
3. **Vulnerability**: "Vulnerability" refers to the propensity of exposed elements—people, ecosystems, biodiversity, economic markets, supply chains, and company operations—to suffer adverse effects when exposed to climate-related physical hazards.

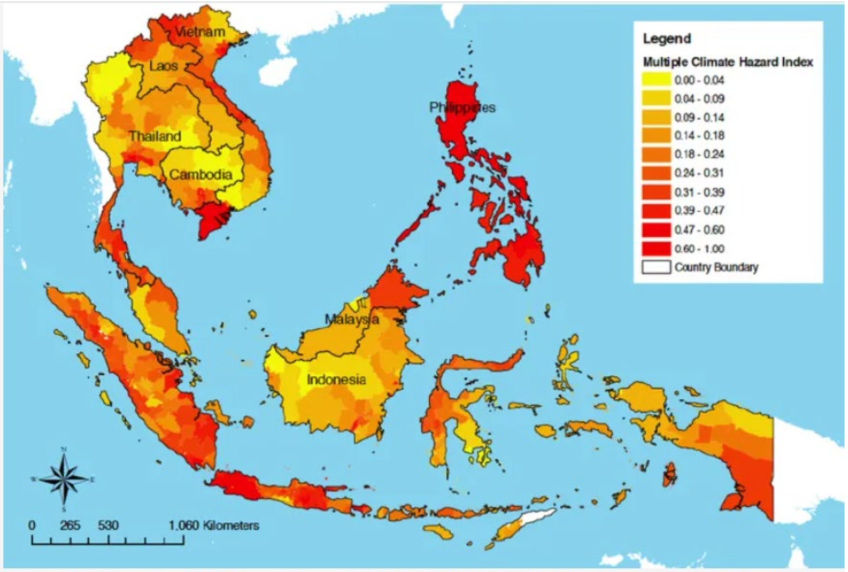
Figure 14.1 shows the vulnerability assessment for Southeast Asia. This region faces a dual challenge. It not only must adapt to climate change caused largely by GHG emitted over decades by advanced economies—and more recently by developing economies, such as China and India—it also must alter development strategies that are increasingly contributing to global warming. The region's reliance on coal and oil, along with deforestation, are undermining national pledges to curb emissions and embrace cleaner energy sources. Governments are under pressure to act quickly or risk giving up improvements in living standards and poverty reduction achieved through decades of export-driven growth.

Table 14.1: Climate Variability, Exposure and Resiliency.

Country	Exposure to Impact			Resilience
	Land area where elevation is below 5 meters (% of land area)	Population living in areas where elevation is below 5 meters (% of total population)	Population affected by droughts, floods, and extreme temperatures (average annual; % of total population)	Disaster risk reduction progress score (1, worst to 5, best)
	2010	2010	2009	2011
Brunei Darussalam	0.4	1.6	--	2.8
Cambodia	2.7	7.2	6.6	--
China	1.2	6.6	8	--
Indonesia	2.8	7.4	0.2	3.3
Japan	3.4	12.6	0	4.5
Korea, DPR	1.8	5.1	2.5	--
Korea, Rep.	2.9	3	0.1	--
Lao PDR	0	0	2.7	2.3
Malaysia	1.3	5.1	0.1	3.8
Philippines	2.6	5.7	0.8	--
Singapore	8.2	10.3	--	--
Thailand	2.9	10.3	3.8	3.8
Timor-Leste	0.7	0.9	0	--
Viet Nam	15.4	37	1.6	--

Source: World Bank 2021.

Figure 14.1: Vulnerability Index on Climate Change in Southeast Asia.



Vulnerability to climate change in Southeast Asia accounting for exposure to climate hazards, sensitivity and adaptive capacity. 0 = lowest vulnerability, 1 = highest vulnerability. Source: ResearchGate

Source: EEPSEA-IDRC (2009).

Pressures

Energy mix

Energy demand will grow as much as 66 percent by 2040, and coal alone will account for almost 40 percent of the increase (Prakash, 2018). That poses a risk to the Paris Climate Agreement's goal of limiting the average global temperature gain to 2°C above preindustrial levels. Although the region's GHG emissions have been low relative to those of advanced economies in per capita terms, that is starting to change, largely because of its increasing reliance on coal and other fossil fuels. Demand for coal is partly driven by the fuel's relative abundance and its low cost compared with oil, gas, and renewable energy. Between 1990 and 2010, emissions of CO_2 increased faster in Southeast Asia than anywhere else (Prakash, 2018). Meanwhile, East Asia, as a center of industrial production, is responsible for about 30 percent of energy-related global emissions of CO_2 (Westphal *et al.*, 2013).

Conversion of forests, mangroves, and peat swamps

Deforestation is another major source of GHG. In Indonesia and Malaysia, home to among the world's largest forest areas, trees are cut down and forest burned to make way for farms to feed growing populations, and for the production of pulp and paper, palm oil, and rubber, which are big sources of export revenue. The haze from forest fires has repeatedly affected neighboring countries since 1997. Likewise, mangroves are deforested to make room for shrimp farms, agriculture, palm oil plantations, ports, tourism facilities, housing, and commercial establishments. Destruction of seagrass beds, clearing of forests in peatlands and draining peat swamps released thousands of tonnes of CO_2 trapped in each hectare of soil. The problem is compounded when farmers burn the dry peat, releasing the gas more quickly.

Urbanization and migration

Rapid economic growth and urbanization are contributing to climate change while also magnifying its impact. Migrants from rural areas flock to cities. New construction in floodplains blocks waterways, leaving cities more vulnerable to floods. And the more cities grow, the greater the damage from increasingly frequent floods and storms.

Flooded rice field in Pampanga, Philippines *(Photo by M. Ebarvia)*

14.2 Sea Level Rise

Sea level rise poses an existential threat to people living along the coasts and on low lying islands. Coastal areas, especially in Southeast Asia, are more vulnerable to climate change-driven rising sea levels than previously predicted. The Intergovernmental Panel on Climate Change (IPCC) lists all ASEAN member states except for Singapore, in the top 50 countries that will experience severe weather impacts – four of which are in the top 10. Those who will or are already suffering the most from climate change-affected rising waters are likely to be poor farmers and fishermen who live along or close to their coastlines in Southeast Asia.

Box 14.1. Rising Sea Levels In Southeast Asian Cities

Bangkok continues to sink below sea level. Bangkok, a city of 8.2 million people, was built on marshy land and buildings there have sunk as much as 20 millimeters in recent years, according to scientists. While the practice has officially been banned, more than 50 percent of the sinking has been caused by the tapping of groundwater by industry, according to Anond Sanitwong, director of the Thai Geo-Informatics and Space Technology Development Agency (GISTDA). Adding the figures together means the sinking rate will be about three centimeters (cm), or 30 millimeters (mm) per year.

Indonesia's President Joko Widodo announced in 2020 that Indonesia will move its capital from Jakarta, which has been sinking into the sea, to Kalimatan on Borneo. The worst affected neighborhoods in Jakarta have been sinking at a rate of 10 to 20 cm a year, one of the fastest rates in the world. A World Bank report saying that some 40 percent of Jakarta has sunk below sea level, largely because residents rely on pumping underground water for daily use, causing the land above it to subside. As a result, floodwater does not drain into the sea as it would normally.

In the Philippines, the same sinking phenomenon is affecting offshore islands as well as the coastline near the capital city of Manila. One cause has been unregulated wells being dug for factories and farms.

Meanwhile, along the banks of the 2,700-mile-long Mekong River, which flows through six countries namely China, Myanmar, Lao PDR, Thailand, Cambodia, and Viet Nam, the climate change stakes are especially high. The Mekong's lower region banks are increasingly threatened by rising sea levels, salt intrusions as well as a loss of sediment held back by upstream dams in China and Laos.

Ho Chi Minh City is constantly flooded due to a combination of storms, heavy rainfall, and upstream discharges from reservoirs, while millions of people in Viet Nam's Mekong Delta, the country's fertile rice farming region, could be forced to flee coastal areas.

Source: Southerland 2020.

14.3 Economic Impact

A report from ADB estimated that Southeast Asia could suffer bigger losses than most regions in the world. Unchecked, climate change could shave 11 percent off this region's GDP by the end of the century as it takes a toll on key sectors, such as agriculture, tourism, and fishing—along with human health and labor productivity.[227] This is higher than the previous estimate of a 6.7 percent reduction (ADB 2009). Under the business-as-usual (BAU) scenario, in which current patterns of development continue, the average losses in East Asia due to climate change could amount to 5.3 percent of its annual GDP by 2100.[228]

Dry spells, prolonged droughts, extreme rainfall and typhoons

Rising sea levels, along with prolonged dry spells, will cause salinity intrusion and hurt agriculture in the fertile Mekong Delta, one of the world's most densely populated areas. The delta is Viet Nam's food bowl, producing more than half of its rice and other staples and over 60 percent of its shrimp.[229] In the absence of technical breakthroughs, rice yields in Indonesia, the Philippines, Thailand, and Viet Nam could drop by as much as 50 percent by 2100 from 1990 levels (ADB, 2009). Up to 2050 the biophysical impacts of climate change—changes in temperature and precipitation—are expected to increase total crop production (measured in calories) in Japan and RO Korea but to reduce it by up to 10 percent in China (Westphal et al. 2013).

In the Philippines, 20 typhoons on average make landfall yearly, with increasing destructiveness. Cambodia, Lao PDR, and Thailand are also affected by storms and excessive rain, as well as by heat extremes that take a toll on agriculture and human health.

Fisheries and tourism will also be affected due to the effects of global warming, rising sea temperatures, and ocean acidification on coral reefs, and shell-forming marine organisms.

According to Marcel Marchand (a Hanoi-based expert in flood risk management.): "The impact of a flood or storm is now generally more than in the past. That is not only because there are more hazards, or because hazards are more severe, but also because there are more people, and cities are becoming bigger. He attributes flooding, in part, to the construction of reservoirs in catchment areas upstream, which has changed river flows. The reservoirs become overwhelmed by extreme rainfall events, and excess water released downstream floods Hoi An and nearby Da Nang. While tourism creates jobs, related infrastructure development also indirectly contributes to coastal erosion that makes the area more vulnerable to storm surges and rising sea levels. The shoreline along Hoi An's popular Cua Dai Beach receded by 150 meters in the years from 2004 to 2012, according to a report prepared by the Quang Nam provincial People's Committee. Floodwalls and sandbags have become eyesores for vacationers."[230]

[227] Raitzer *et al.*, 2015.
[228] Westphal *et al.*, 2013.
[229] Raitzer *et al.*, 2015.
[230] Prakash, 2018.

Businesses worldwide are facing climate risks, and companies with operations or supply chains in Southeast Asia are exposed to a range of climate hazards and vulnerabilities that can exacerbate these risks.[231]

14.4 Response: Operationalizing Resilience

Fourteen years ago, a Harvard climate and energy expert, John Holdren, coined a kind of axiom for the three choices climate change posed for humanity: **Mitigation, adaptation,** and **suffering**. "We're going to do some of each. The question is what the mix is going to be. For years, the policy conversation has rightfully been dominated by the first part of the equation—the elimination of greenhouse gas emissions—because the more mitigation we do, the less adaptation will be required and the less suffering there will be."

A report by McKinsey Global Institute (MGI) evaluated economic projections against climate models and found a high magnitude of physical risks that 105 countries will experience in the next three decades. The study suggests that in order to address climate risks, both adaptation measures and decarbonisation are necessary. Unless GHG emissions can be reduced to zero today, governments in the EAS region may need to accept the inevitable transformation of their respective climates and develop a combination of adaptation plans to cope in the future, and mitigation measures, such as emissions abatement to slow and eventually reverse the accumulation of GHG in the atmosphere, and restoration and protection of forests and coastal and marine ecosystems for carbon sequestration..

The EAS countries have a treasure at hand to contribute to the mitigation of climate change. They have mangrove forests, seagrass beds, and salt marshes, which play an important role in carbon removals, and if kept undisturbed, their underlying soils act as long-term carbon sinks. The EAS region has the potential to do both nature-based solution and innovative, low carbon-high growth strategy. Effective action on climate change will require a combination of emissions reductions and atmospheric carbon removals.

14.4.1 Blue Carbon Programs: Restoration and Protection of Coastal and Marine Ecosystems

> *"The successful Paris Agreement at COP21 provides fresh positive energy and new momentum to carbon markets, so we are looking forward to a very interesting couple of years for forest carbon, with increased market activity and bullish price movements on both the private (voluntary and pre-compliance) and public (government-to-government and institutional) sector side."*[232]

[231] Gallagher, E., 2018.

[232] Edit Kiss, Director of Business Development and Operations, Althelia Ecosphere. http://www.ecosystemmarketplace.com/articles/your-2016-carbon-market-predictions/

Article 5 of the Paris Agreement invites countries to take action to conserve and enhance sinks and reservoirs of GHG, including forests. This article also encourages actions to implement and support, including through results-based payments, the existing Warsaw Framework for REDD+ adopted in COP 19, and alternative policy approaches, such as sustainable management of forests.

Climate Change solutions include CO_2 extraction from atmosphere and water with burial by living habitats in sediment/soil. The *IPCC's 2018 Special Report on Global Warming of 1.5°C* and the *IPCC's 2019 Special Report on Climate Change and Land* both highlighted the importance of urgently implementing nature-based solutions (NBS) to remove large quantities of carbon from the atmosphere at comparatively low cost, while simultaneously delivering a host of co-benefits (e.g., healthy fisheries, improved soil productivity, clean air and water, resilience to storms and flooding, maintaining biodiversity, etc.).

A comprehensive analysis of natural climate solution (NCS)—covering 20 conservation, restoration, and/or improved land management actions that increase carbon storage and/or avoid GHG emissions across global forests, wetlands, grasslands, and agricultural lands—show that NCS can provide **a third of the emissions reductions needed by 2030** to keep global warming below 2 °C.[233]

Blue carbon ecosystems are significant for the global climate by storing and sequestering atmospheric carbon. Recently, it has been recognized that coastal ecosystems contain much more carbon per unit area than many terrestrial ecosystems.

Blue Carbon strategy refers to the approaches that mitigate and adapt to climate change through the conservation and restoration of seagrass, saltmarsh and mangrove ecosystems and, in some blue carbon programs, also through the expansion of seaweed aquaculture. However, sufficient finance is needed to drive the scaling of blue carbon restoration and conservation activities. Blue carbon activities are one type of Natural Climate Solutions (NCS) or nature-based solution (NBS).

To include blue carbon ecosystems in GHG National Inventory and Communications, countries need to map their ecosystems, their status, change through time, and threats, and quantify their carbon sequestration and storage as well as emissions and removals due to land and coastal management.

The **International Blue Carbon Initiative** is a coordinated, global program focused on mitigating climate change through the conservation and restoration of coastal and marine ecosystems.

Together, the 2030 Agenda for Sustainable Development, the Paris Agreement under the UNFCC, and the Sendai Framework for Disaster Risk Reduction 2015–2030 provide the foundation for sustainable, low-carbon and resilient development in a changing climate.

[233] Griscom, B. *et al.*, 2017.

Indonesia. Recognizing the value of blue ecosystems, Indonesia established the **National Priority for Blue Carbon Program**, under which several actions are being carried out, such as assessment of the blue carbon value; community mangrove and seagrass restoration; capacity building in sustainable fisheries and alternative livelihoods; expanding the science program; integrating Blue Carbon into on-the-ground sustainable use, conservation and management; etc.[234] The **Indonesia Blue Carbon Strategy Framework** is integrated into the National Medium-Term Development Plan (RPJMN) 2020-2024.

Philippines. The Blue Carbon Steering Committee (BCSC) and the Blue Carbon Technical Working Group (BCTWG) provide advice to the Cabinet Cluster on Climate Change Adaptation and Mitigation (CCAM) for the development and implementation of the **National Blue Carbon Initiative**. The Philippines intends to harness the adaptation and mitigation potential of Blue Carbon, which could be included in the subsequent submission of the Nationally Determined Contributions.

Singapore. Blue carbon is important even in fragmented mangroves, and Singapore is undertaking a project to measure, conserve and restore blue carbon along a complex urban coastline. **Natural Capital Singapore** is a three-year project (started in 2018), which aims to conduct a national-scale assessment of Singapore's natural capital and ecosystem services, quantify their economic and societal value, predict potential future changes in natural capital, identify trade-offs and synergies with future urban development, and develop an interactive decision-support tool that will provide information on natural capital to decision-makers.[235]

14.4.2 Blue Carbon Market: Supporting the Climate Ambitions

The need for innovative financing mechanisms is becoming critical to developing a Blue Economy. One such opportunity lies in emerging global carbon markets. These markets pertain to the sale and purchase of carbon offset credits from projects that genuinely reduce or sequester GHG emissions, e.g., avoided deforestation, reforestation, energy efficiency, and renewable energy. It has been pointed out that despite the huge potential to deliver GHG emission reductions, NCS, as a whole, currently receive just **3 percent of total climate investment globally**.[236]

Developing Blue Carbon offset projects could provide a funding mechanism and incentive to strengthen conservation efforts and more sustainable land-use alternatives to slow, halt and even reverse losses of mangroves, salt marshes, and seagrass ecosystems. Through a process of accounting and verification under internationally accepted standards, carbon offset project developers (including landholders or local government) may be awarded carbon offset credits for two types of activities: (1) replanting a degraded marine ecosystem; or (2) avoiding the clearance of an existing marine ecosystem. The challenge is to increase understanding of this opportunity, and make the Blue Carbon market work 'on the ground'.

234 PEMSEA, 2015; Hutahaean, 2015.
235 www.naturalcapital.sg.
236 https://verra.org/two-new-biosequestration-working-groups/.

Box 14.2. Recommendations for countries to incorporate blue carbon ecosystems into integrated coastal management, climate response, biodiversity conservation, and blue economy planning.

Build awareness

- **Include blue carbon in policy dialogue.**
- **Apply 2013 IPCC Wetland Supplement and include blue carbon ecosystems in GHG National Inventory and Communications.**
- **Report trends of coastal ecosystems, including improved mapping of blue carbon ecosystems, their change through time, threats, and status.**

Facilitate knowledge exchange

- **Join networks**, such as the International Partnership for Blue Carbon and the International Blue Carbon Initiative.
- **Facilitate / contribute to technical and policy workshops** (e.g., The Blue Carbon Initiative).
- **Support science programs and technical analysis.**
- **Develop knowledge products and demonstration activities**, e.g., activities under GEF Blue Forest Project and by Restore America's Estuaries.

Accelerate practical action

- **Investigate appropriate policy frameworks for including blue carbon ecosystems within national commitments to the Paris Agreement.** Including blue carbon ecosystems within NDCs and related plans provides guidance to coastal planners and assists in securing international funding for climate adaptation and mitigation.
- **Include management of blue carbon ecosystems within ICM plans.**
- **Assess and promote national opportunities for conservation and restoration of blue carbon ecosystems, including quantification of GHG reduction benefits.**
- **Provide training and technical support to local and national government agencies, field schools and communities on the value of blue carbon ecosystems and good practice for conservation and restoration.**
- **Develop climate change adaptation strategies that consider migration of blue carbon ecosystems with sea level rise and human impacts (such as dam construction) on sediment supply to coastal regions.**

Box 14.2. Recommendations for countries to incorporate blue carbon ecosystems into integrated coastal management, climate response, biodiversity conservation, and blue economy planning. (cont.)

- **Include blue carbon ecosystems in coastal vulnerability assessments.** Along with hard infrastructure, natural infrastructure, including blue carbon ecosystems, is an important element in reducing ecosystem and human vulnerability to climate change. Developing blue carbon vulnerability assessments will empower governments and communities to manage natural resources into the future
- **Include blue carbon ecosystems in national economic development plans.** Recognizing the natural capital value of intact and restored blue carbon ecosystems in economic development plans can support development of sustainable blue economies.
- **Include blue carbon ecosystems as a component of natural infrastructure.** Coastal and river wetlands provide valuable flood risk reduction services. Including wetlands in development plans provides additional levels of protection during storm and high-low events, along with additional ecosystem services not provided by hard infrastructure.
- **Include blue carbon ecosystems within MPAs.**
- **Include blue carbon ecosystems as part of marine spatial planning (MSP) and other tools for managing multi-use coastal areas.**
- **Develop/apply soil management plans for watershed and coastal regions.** Improved soil management results in reduced release of carbon either through erosion or directly to the atmosphere in the form of carbon dioxide or methane.
- **Correlate health of blue carbon ecosystems with industry inputs and outputs of blue economy.** Clarify the interdependency of blue economy industries with function of coastal ecosystems. Minimize industry environmental liabilities and maximize benefits.

Source: Crooks, et al. 2017.

14.4.3 Climate Schemes that Put a Price on Carbon Emissions

A World Bank report showed that more than a fifth of the world's GHG emissions are now covered by a price on carbon dioxide (CO_2) emissions to help meet climate goals.[237] A price on carbon helps shift the burden for the damage back to those who are responsible for it, and who can reduce it. Moreover, carbon prices reduce emissions by making low- and zero-carbon energy more competitive compared to high-carbon alternatives, and by encouraging reduced use of carbon containing fuels.

The effective carbon rate is the sum of (a) tradeable emission permit prices, (b) carbon taxes, and (c) fuel excise taxes, all of which result in a price on carbon emissions.

[237] World Bank, 2021p.

A carbon cost can come in the form of a **tax** or via an **emissions trading system** (ETS), or cap-and-trade scheme.

- **Carbon tax.** A carbon tax is a fee on the carbon content of fossil fuels. This is a form of pricing instrument. Under a carbon tax, the government sets a price that emitters must pay for each tonne of GHG emissions they emit.
- **Emissions trading systems.** An ETS sets a gradually decreasing cap on the emissions a sector, or group of sectors, can produce. It creates "carbon permits" for those emissions, which companies must buy for each tonne of CO_2 they emit. Some sectors are given free permits to help maintain international competitiveness.

The carbon tax can accelerate the decarbonization of economies. A study of OECD countries showed that a carbon tax of EUR10 per tonne of CO_2 can reduce emissions by around 7.3 percent.[238] However, either carbon pricing instrument – carbon tax or ETS – requires a system to measure, report and verify GHG emissions, and this takes time to be put in place. Singapore is implementing a carbon tax for industrial activities, while China and RO Korea have ETS (**Box 14.3**).

Box 14.3. Major Carbon Emissions Trading Systems

Below are some of the major carbon emissions trading systems around the world:

- **GREAT BRITAIN:** Britain launched a domestic ETS in 2021 after leaving the European Union scheme following Brexit. It covers power plants, aviation, and energy-intensive industries.
- **EUROPEAN UNION:** The world's largest ETS, which started 16 years ago, is mandatory for all 27 EU members, plus Iceland, Liechtenstein, and Norway, covering power plants, aviation, and energy-intensive industries.
- **KAZAKHSTAN:** Its scheme started in 2013. It was suspended in 2016 and relaunched in 2018 after undergoing reforms. It covers the energy sector, mining, and chemical industries.
- **NEW ZEALAND:** Its ETS, which began in 2008, covers electricity generators and manufacturers of liquid fossil fuels including petrol and diesel. Some forest owners are given free permits, while others can voluntarily join the scheme.
- **SINGAPORE**: Singapore does not have an ETS but has a carbon tax covering all industrial operation that emit direct greenhouse emissions equal to or above 25,000 tCO_2e (tonnes of carbon dioxide-equivalent) annually. The tax, payable from Jan 1, 2019,

[238] OECD. 2021.

Box 14.3. Major Carbon Emissions Trading Systems (cont.)

is presently S$5 per tonne of emissions. A review the tax rate is due by 2023, or possibly earlier.

- **SOUTH KOREA**: Its ETS started in 2015. It covers about 600 of the biggest emitters, collectively responsible for almost 70 percent of the country's annual emissions.
- **CHINA**: A national ETS covering the power sector was launched in 2021 following pilot schemes in provinces and cities including Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen, and Tianjin.
- **MEXICO:** A three-year pilot scheme was launched in 2020 covering the power, oil and gas, and industrial sectors.
- **QUEBEC, CANADA:** Its scheme was launched in 2012 and covers electricity and energy-intensive industrials.
- **UNITED STATES:** The United States does not have a national ETS, but many regions and states use carbon pricing, such as California and states covered by the Regional Greenhouse Gas Initiative (RGGI), e.g., Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

Source: World Bank, 2021b.

14.4.4 Adaptation and Climate-resilient Infrastructure

The climate resiliency of public and private infrastructures is a multidimensional issue that requires convergence between the need to develop the economic and social infrastructure of the country and the necessity to protect the country's ecosystems. The restoration of ecosystems and their capacity to regulate the impacts of climate change will reduce risks and slow down the deterioration of infrastructure as well as increase the possibility of new investments.

Adapting infrastructure to the risks of climate change within the broader blue and green strategies not only helps to reduce the loss of lives, physical damages and interruptions in critical socio-economic services, but it also yields additional benefits from greater energy security, reduction of GHG emissions, and biodiversity conservation.

Structural measures include any physical construction to reduce or avoid possible impacts of hazards, such as flood levees, ocean wave barriers, etc. To complement and support the blue-green natural barriers and structural measures, non-structural interventions are also important, such as building codes, marine spatial plan and land-use planning laws and their enforcement, and public awareness programs.

Cambodia: Polder dyke rehabilitation

A project in Cambodia combined hard infrastructure with 'green' infrastructure and capacity development to adapt to climate change. The 7500-m polder and outer polder dyke at Prey Nob District in Preah Sihanouk were rehabilitated to prevent seawater intrusion. The project also involved planting of 60,000 seedlings of *Teaptrus* trees to protect 20,000 ha polders, installing 60 rainwater harvest tanks benefiting 50 households in Prey Nob District and 10 households in Peam Krasaob, as well as mangrove planting and integrated farming system to improve resilience of coastal communities against both flooding and drought.[239] These activities demonstrated that the interventions not only will help towards improving livelihood security effectiveness, but also enhance local Provincial budget efficiencies with regards to supporting socio-economic development at the commune level.[240]

China: Eco-sponge city

In China, the eco-sponge city is the new concept of urban stormwater management in view of waterlogging, water quality degradation and other major hydrological safety problems in the cities. The government has called for "strengthening the building of sponge cities characterized by natural storage, natural infiltration, and natural purification" to ensure that cities are resilient to deal with environmental changes and natural disasters brought about by rainwater and flooding.[241] The idea of a sponge city is simple: rather than using concrete to channel away rainwater, people work with nature to absorb, clean and use the water. Eco-friendly terraces allow land and water to meet. During the dry season, the terrace is a park for residents to enjoy, while during the rainy season it can flood, protecting the city without the need for grey infrastructure like flood walls or dykes. Not only does this safeguard the city by working with nature, but the water is clean, vegetation can grow, and a habitat is created for wildlife. Sponge cities also include green walls and roofs, permeable pavements, and green buildings.

Xiamen is one of the pilot sponge cities. *(Photo by PEMSEA)*

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[239] PEMSEA and MOE (Cambodia). 2019.
[240] UNEP. 2017b.
[241] PEMSEA. 2018b.

15 Large Marine Ecosystems: Navigating the Transboundary Issues and Shared Resources

Let us be good stewards of the Earth we inherited. All of us have to share the Earth's fragile ecosystems and precious resources, and each of us has a role to play in preserving them. If we are to go on living together on this earth, we must all be responsible for it.
Kofi Annan

What are LMEs?

Between the world's continental margins and the open ocean are 66 Large Marine Ecosystems or LMEs (**Figure 15.1**). These are vast regions of coastal ocean space of 200,000 km^2 or more, extending from river basins and estuaries seaward to the continental shelf break or slope or to the outward margins of major current systems.[242] All LMEs are transboundary in nature by virtue of interconnected currents, movement and migration of living resources, and pollution that straddle political boundaries.

Since Dr. Kenneth Sherman and colleagues developed the LME concept in 1991, the LME has been widely adopted as the geographical unit for ecosystem-based management of coastal marine areas and their living resources. The LME Approach combines the legal principles of the United Nations Convention on the Law of the Sea (UNCLOS) with a multi-sectoral and multidisciplinary strategy for assessing and managing the changing state of the LMEs.[243] These highly productive areas of the ocean share six main priority threats:[244]

- Water quality degradation from multiple pollution sources;
- Decline in living marine resources from over-exploitation;
- Collapse in ecosystem integrity and loss of biodiversity;
- Habitat degradation and loss;
- Invasive species; and
- Climate change.

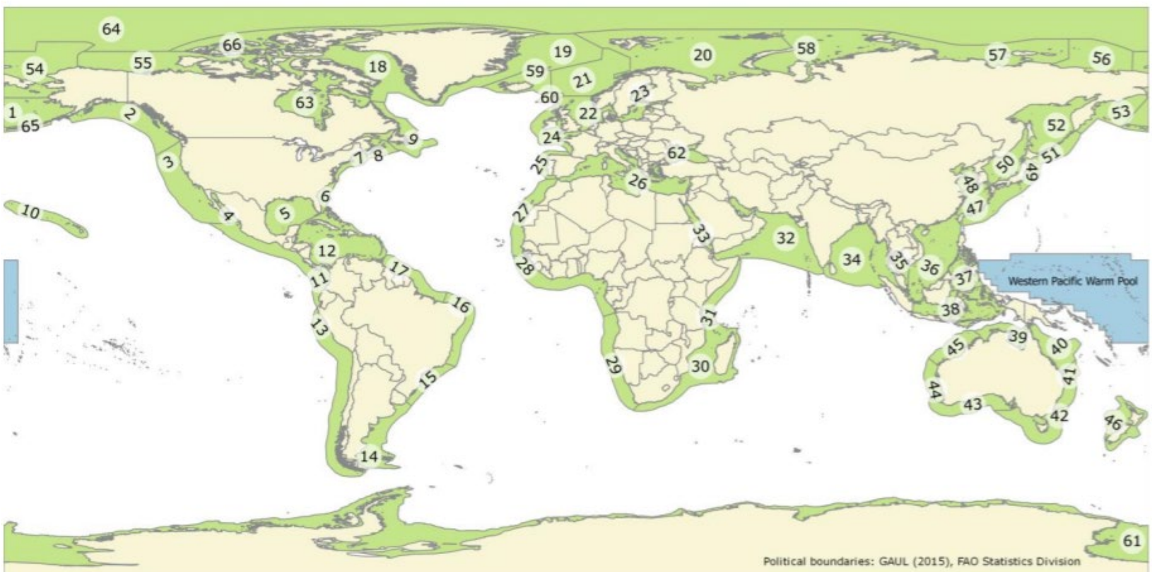
LME Approach to ecosystem-based management (EBM)

The LME approach is based on the best available science applied to assess changing conditions or states of the environment and major components of the biogeochemical processes to support governance of marine goods and services within the spatial domains of entire LMEs. The GEF's

[242] UNESCO/IOC, GEF and UNDP TWAP 2015f.
[243] Sherman, 2019.
[244] UNDP, 2017.

International Waters focal area has utilized the LME approach to navigate the complex problems related to transboundary issues affecting the world's marine ecosystems. The GEF developed the Transboundary Diagnostic Analysis-Strategic Action Programme (TDA-SAP) assessment and strategic planning processes to help countries learn how to work together and coordinate the interrelated science and policy activities necessary for effective ecosystem management. This formal and inclusive process analyses all relevant factual and scientific information to set priorities for action.

Figure 15.1: Large Marine Ecosystems in the World.



Source: UNESCO-IOC/GEF/UNEP TWAP 2015f.

1: East Bering Sea
2: Gulf of Alaska
3: California Current
4: Gulf of California
5: Gulf of Mexico
6: Southeast U.S. Continental Shelf
7: Northeast U.S. Continental Shelf
8: Scotian Shelf
9: Labrador - Newfoundland
10: Insular Pacific-Hawaiian
11: Pacific Central-American Coastal
12: Caribbean Sea
13: Humboldt Current
14: Patagonian Shelf
15: South Brazil Shelf
16: East Brazil Shelf
17: North Brazil Shelf
18: Canadian Eastern Arctic - West Greenland
19: Greenland Sea
20: Barents Sea
21: Norwegian Sea
22: North Sea
23: Baltic Sea
24: Celtic-Biscay Shelf
25: Iberian Coastal
26: Mediterranean Sea
27: Canary Current
28: Guinea Current
29: Benguela Current
30: Agulhas Current
31: Somali Coastal Current
32: Arabian Sea
33: Red Sea
34: Bay of Bengal
35: Gulf of Thailand
36: South China Sea
37: Sulu-Celebes Sea
38: Indonesian Sea
39: North Australian Shelf
40: Northeast Australian Shelf
41: East Central Australian Shelf
42: Southeast Australian Shelf
43: South West Australian Shelf
44: West Central Australian Shelf
45: Northwest Australian Shelf
46: New Zealand Shelf
47: East China Sea
48: Yellow Sea
49: Kuroshio Current
50: Sea of Japan
51: Oyashio Current
52: Sea of Okhotsk
53: West Bering Sea
54: Northern Bering - Chukchi Seas
55: Beaufort Sea
56: East Siberian Sea
57: Laptev Sea
58: Kara Sea
59: Iceland Shelf and Sea
60: Faroe Plateau
61: Antarctica
62: Black Sea
63: Hudson Bay Complex
64: Central Arctic
65: Aleutian Islands
66: Canadian High Arctic - North Greenland

This approach involves first developing a comprehensive assessment of the scientific knowledge of the ecosystem, and this includes an evaluation of the primary problems and threats to the ecosystem. This information is presented as the **Transboundary Diagnostic Analysis** (TDA) and reflects the joint efforts of the nations involved. The TDA thus provides an agreed-upon set of information on which to develop the management strategies.

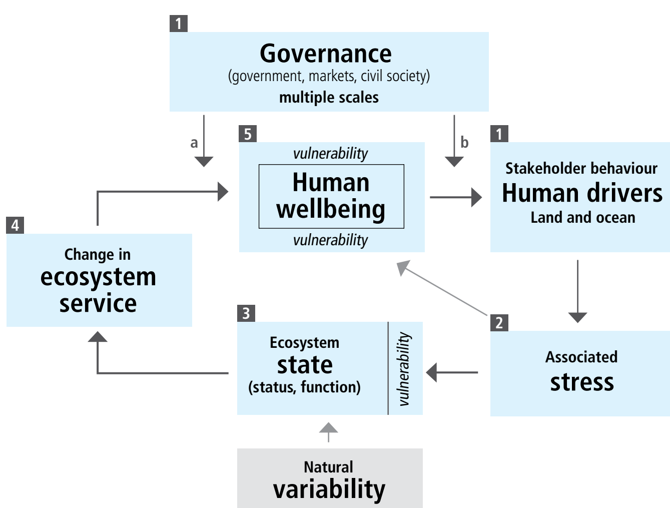
The second part of the GEF approach is to take the results of the TDA and develop a set of ecosystem quality objectives for the sustainable management of the ecosystem. These objectives are realized through the development of management actions with measurable outcomes. These efforts result in a **Strategic Action Programme** (SAP). The SAP is a politically negotiated document that provides a blueprint for attaining a sustainable ecosystem.

A conceptual framework was developed that shows the link between the human and natural systems, to help facilitate the assessment of the impacts of human and natural stressors on LME health and provision of ecosystem goods and services, and consequences for humans and implications for governance of these water bodies (**Figure 15.2**). Five modules and their associated indicator metrics serve as the primary source of data and information to inform strategic planning and implementation:[245]

- natural science indicators for measuring LME: (i) productivity, (ii) fish and fisheries, (iii) pollution and ecosystem health
- social science metrics related to: (iv) socioeconomics, and (v) governance.

This chapter presents the information from the Transboundary Waters Assessment Programme (TWAP) reports and factsheets, TDA and environmental risk assessment of the LMEs in the EAS Region, SAPs, as well as reports and presentation materials shared by the Country and Non-Country Partners of PEMSEA.

Figure 15.2: LME Conceptual Framework.



Source: UNESCO-IOC/GEF/UNEP TWAP, 2015f.

[245] Sherman, 2005.

15.1 Key Features and Economic Aspects of the LMEs in the EAS Region

The countries in the EAS region straddle the following LMEs: Bay of Bengal, East China Sea, Indonesian Seas, Gulf of Thailand, Kuroshio Current, Sea of Japan, South China Sea, Sulu-Celebes (Sulawesi) Seas, Indonesian Seas, and Yellow Sea. An overview of the location, aerial extent, primary productivity and biodiversity of these LMEs are presented in **Tables 15.1** and **15.2**.

Table 15.1: Large Marine Ecosystems (LMEs) in the EAS Region.

LME	LME Total Area[a] (km^2)	Average Depth[b] (m)	Bordering Economies
Bay of Bengal	3,657,502	2,600	Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka, Thailand
East China Sea	1,008,066	370	China, RO Korea, Japan
Indonesian Seas	2,289,597	2,935	Indonesia, Timor Leste
Gulf of Thailand	391,665	45	Cambodia, Malaysia, Thailand, Viet Nam
Kuroshio Current	1,333,074	--	Philippines, Taiwan (China), Japan
Sea of Japan	1,054,305	1,752	Japan, RO Korea, DPR Korea
South China Sea	5,660,985	1,024	Brunei Darussalam, China, Indonesia, Malaysia, Philippines, Singapore, Viet Nam
Sulu-Celebes Sea	1,015,737	1,570	Indonesia, Malaysia, Philippines
Yellow Sea	438,619	44	China, DPR Korea, RO Korea

Source: [a] UNESCO/IOC, GEF and UNDP TWAP 2015 (a-f).; [b] UNEP/GIWA 2005 (a-c).

Table 15.2: Coastal and Marine Habitats and Biodiversity in the LMEs.

LME	Primary Productivity, Average[a] ($gC/m^2/yr$)	Primary Productivity[a] ($gC/m^2/yr$)	Habitats And Biodiversity[b]
Bay of Bengal	332	• Min: 288 in 2013 • Max: 430 in 1998	
East China Sea	435	• Min: 379 in 2011 • Max: 541 in 1998	• 160-419 species of phytoplankton • 174-697 species of zooplankton • 102-491 species of fish • 77 species of mollusks • 77 species of polychaetes • 95 species of crustaceans • 136 species of protozoa • 203 species of nekton
Indonesian Seas	380	• Min: 329 in 2013 • Max: 421 in 1999	• 47 species of mangroves • 13 species of seagrass • 500 species of reef-building corals • 2,500 species of fish

Table 15.2: Coastal and Marine Habitats and Biodiversity in the LMEs. (cont.)

LME	Primary Productivity, Average[a] (gC/m^2/yr)	Primary Productivity[a] (gC/m^2/yr)	Habitats And Biodiversity[b]
Gulf of Thailand	401	• Min: 369 in 2013 • Max: 431 in 2003	• 5 species of seagrass • 300 species of fish • mangroves cover 36% of shoreline • reef area: 78.56 km^2
Kuroshio Current	156	• Min: 137 in 2012 • Max: 186 in 1999	
Sea of Japan	207	• Min: 180 in 2008 • Max: 242 in 1999	• 800 species of aquatic plants • >3,500 animal species • 1,000 fish species • 900 species of crustaceans • 26 mammals
South China Sea	285	• Min: 263 in 2013 • Max: 295 in 2007	• 45 species of mangroves • 50 genera of corals • 500 species of reef-building corals • 20 species of seagrass • 2,500 species of fish • 6 species of marine turtles • 7 species of giant clams
Sulu-Celebes Sea	257	• Min: 218 in 2013 • Max: 284 in 1998	• 400 species of reef-building corals • 2,500 species of fish • 5 species of marine turtles • 22 species of marine mammals
Yellow Sea	635	• Min: 560 in 2003 • Max: 742 in 2013	• 70 species of phytoplankton • 300 species of benthic diatoms • 300 species of marine algae • 50 species of halophytes • 150 species of fish • 500 species of marine invertebrates • 230 species of water birds • 10 species of marine mammals
Arafura–Timor Sea*			• 160 species of coral • 350 species of reef fish • 25% of the world's mangroves • 45 mangrove tree species • 15 species of seagrass • Marine turtles, dugong, sharks and rays • Nesting colonies of shorebirds and seabirds • Extremely rich in non-living natural resources, e.g., oil and gas reserves

* Part of the North Australian Shelf Large Marine Ecosystem (LME 39)
Source: [a] UNEP, 2016. TWAP; [b] UNEP, 2005. GIWA (a-e).

Ocean economy in the LMEs

The LMEs in the EAS region have the world's most biodiverse habitats, such as mangroves and coral reefs, which provide important resources, goods, and ecosystem services that translate into income, livelihoods, food and energy security, trade, recreation, resiliency, and other benefits for millions of people in the region and around the world. These LMEs are at the heart of the ocean-climate nexus as well as ocean-related sectoral activities, including fisheries, tourism, shipping and shipbuilding, oil and gas exploitation, marine renewable energy, ocean science and research, etc. The major ocean resources and ocean-based economic activities are described below for some of the LMEs in the region.

Bay of Bengal (LME 34)[246]

Fisheries. The Bay of Bengal has a distinct tropical marine ecosystem, and river drainage into the northern part of the bay and the profusion of wetlands, marshes, and mangroves increase productivity of nearshore fish species. The exploitation of these resources is carried out by small-scale fisheries, while commercial fishing in deeper waters is done largely by countries bordering the bay and by Japan. The annual catch of prawns, the major export crop, has remained stable despite intensified harvesting. Several species of tuna found in the bay also are important. The tuna fishery is confined to the true oceanic sector of the bay, south of latitude 15°N, since freshwater runoff from the large rivers greatly influences the nearshore waters.

Oil and gas. Petroleum and natural-gas discoveries have been made in the Bay of Bengal, notably offshore of the Godavari and Manandi deltas. The bay has a geologic setting similar to that of the Indus River basin and the western margin of the Indian Peninsula. Hydrocarbon resources in the Bay of Bengal generally are located in deep areas, as compared to those in the Arabian Sea.

Mining. There are placer deposits of titanium off north-eastern Sri Lanka and rare earths off north-eastern India. Heavy mineral sands occur around Nagapatnam (in Tamil Nadu state) on the south-eastern Indian coast, near Chennai (Madras), and in coastal areas around Vishakhpatnam. They consist of ilmenite, garnet, sillimanite, zircon, rutile, and manganite.

Ports and shipping. The principal trade routes for large tankers en route from the Persian Gulf to the Strait of Malacca pass south of the Bay of Bengal. Hence, oceanic transportation is limited to carriage of cargoes to and from Sri Lanka, Bangladesh, and the east coast of India. Principal ports in India are Kolkata (Calcutta), Haldia, Vishakhapatnam, Chennai, Cuddalore, and Paradeep. Sri Lankan ports of importance are Colombo and Trincomalee. Dhaka and Chittagong are noteworthy in Bangladesh, and Akyab (Sittwe) is Myanmar's chief port on the Bay of Bengal. Haldia, Vishakhapatnam, and Paradeep are well developed as iron ore terminals.

[246] The information about the Bay of Bengal in this section is from the online Britannica. https://www.britannica.com/place/Bay-of-Bengal/Economic-aspects.

East China Sea (LME 47)[247]

Fisheries. The East China Sea is a region of high marine-life productivity, and China, Japan, and DPR Korea and RO Korea actively fish in the area. Most of the fishing is done by small local boats, although larger trawlers are also used. Tuna, mackerel, shrimps, sardines, milkfish, sea breams, croakers, shellfish, and seaweeds are the main resources harvested.

Oil and gas. Petroleum and natural gas deposits have been discovered under the continental shelf of the East China Sea. A small amount of China's oil and natural gas production comes from offshore wells in the East China Sea.

Ports and shipping. In addition to the local shipping traffic in and out of Chinese and Korean ports, the East China Sea serves as the main shipping route from the South China Sea to Japanese and other North Pacific ports. Among the main ports of the East China Sea are Shanghai in China, and Nagasaki in Japan.

South China Sea (LME 36)

The South China Sea is rich in marine life. Contributing to this abundance are the extensive runoff of nutrient-laden waters from land and the upwellings of water in certain areas of the sea. The natural resources include fish, guano, oil and natural gas. Economic activities include commercial fishing, shipping, guano mining, oil and gas exploitation, and more recently, tourism.

Fisheries. Fish is the main source of animal protein for the densely populated Southeast Asian area. Most abundant are the various species of tuna, mackerel, croaker, anchovy, shrimp, and shellfish. Nearly the entire catch is consumed locally, either fresh or preserved. However, the sea is heavily fished.

Oil and gas. Large reserves of oil and natural gas have been discovered under the floor of the South China Sea. The main locations for hydrocarbon production are located north of Borneo, east of the Malay Peninsula, and northwest of Palawan.

Guano. Birds, such as boobies and seagulls, are very common on the islands. Their faeces can build up to a layer from 10 mm to 1 m annually. Guano is a highly effective fertilizer.

Shipping lanes. The South China Sea contains some of the world's most important shipping lanes. The main route to and from Pacific and Indian ocean ports is through the Strait of Malacca and the South China Sea. Generally, oil and minerals move north, and food and manufactured goods move south.

[247] The information about the East China Sea in this section is from the online Britannica. https://www.britannica.com/place/East-China-Sea/Economic-aspects

Yellow Sea (LME 48)[248]

Fisheries. The Yellow Sea, like the East China Sea, is famous for its fishing grounds. The rich demersal (bottom-dwelling) fish resources have been exploited by Chinese, Korean, and Japanese trawlers for years. Although the overall annual catch has grown, the catch by the Japanese has decreased, while those of the Chinese and South Koreans have increased. The main species caught are sea bream, croakers, lizard fish, prawns, cutlass fish, horse mackerel, squids, and flounders; all species, however, are overfished, and the catch of particularly valuable species has declined.

The sea is rich in seaweed (predominantly kelp, *Laminaria japonica*), cephalopods, crustaceans, shellfishes, clams, and especially in blue-green algae, which bloom in summer and contribute to the water color.

Oil. Oil exploration has been successful in the Chinese and North Korean portions of the Yellow Sea. In addition, the sea has become more important with the growth in trade among its bordering countries.

Ports. The main Chinese ports are Dalian, Tianjin, Qingdao, and Qinhuangdao; the main South Korean port is Incheon, the outport for Seoul; and that for DPR Korea is Nampho, the outport for Pyongyang.

Sea of Japan (LME 50)[249]

Fisheries and mineral deposits form the main economic resources of the Sea of Japan.

Fisheries. *Pelagic* (oceanic) fishes include saury, mackerel, Jack mackerels, sardines, anchovies, herring, sea bream, squid and various species of salmon and trout. The *demersal* (sea-bottom) fishes include cod, pollock, and Atka mackerel. There are also crustaceans like shrimps and crabs. The fishing grounds are for the most part on the continental shelves and their adjacent waters.

Herring, sardines, and bluefin tuna have traditionally been caught, but since World War II the fisheries have gradually been depleted. Squid fishing is carried on in the central part of the sea, salmon fishing in the shoal areas of the north and southwest, and crustacean trapping in the deeper parts. The sea is heavily fished by fleets from Japan, Russia, and North and South Korea.

Oil, gas, and minerals. Mineral resources on or in the sea bottom include magnetite sands as well as natural gas and petroleum deposits off Japan and Sakhalin Island.

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[248] The information about the Yellow Sea in this section is from the online Britannica. https://www.britannica.com/place/Yellow-Sea.

[249] The information about the Sea of Japan in this section is from: https://www.britannica.com/place/Sea-of-Japan/Economic-aspects

Ports. Trade across the Sea of Japan is only moderate, since most of Japan's trade is with countries not bordering the sea. Consequently, the most important Japanese ports are located on its Pacific coast. Important ports of RO Korea are Pusan, Ulsan, and P'ohang, located on the southeast coast of the country, but most of the shipping in and out of these ports is also destined for countries not bordering the sea. Primary Russian ports are Vladivostok, Nakhodka, and Vostochny. Vladivostok's traffic is primarily with other Russian ports, while Nakhodka and Vostochny are international ports. Trade between countries around the sea, however, has increased, spurred by the growth of the South Korean economy and by the development of trade agreements with Russia.

Box 15.1. Arafura - Timor Seas (ATS): Valuation of Ecosystem Services

Major ecosystems in the ATS region include mangroves, freshwater and estuarine wetlands, coral reefs, and seagrass beds. The estimated value from all ecosystem services in the ATS region is US$ 7,368,484,444.84 to 7,376,959,861.52. This is the sum of the following:

Fisheries represent the most important sector in the ATS region. The total value from marine capture fisheries at the ATS region is estimated at US$742,023 million. The total value from aquaculture for the ATS region is US$ 640,176,810.08 per year. These figures do not include the value of fisheries and aquaculture in Papua New Guinea.

Marine tourism. Ecosystem values from marine tourism were obtained based on several activities such as recreational fishing, marine and coastal tourism, and ship cruises. Total value from tourism reaches US$ 4,970,023,290 per year.

Carbon sequestration. This is an important economic value as regulating service. Total value from this service is about US$ 625,324,583.32 to 663,389,289.06 per year.

Cultural services. Ecosystem values from cultural services including existence, bequest, aesthetic, and indigenous culture reached US$ 263.8 to 897.6 million per year, while total value from biodiversity is about US$ 81,391,487.70 per year.

Source: Choesin et al., 2021.

15.2 Transboundary Waters Assessment

Ocean economic sectors, such as fisheries, aquaculture, seafood processing, biotechnologies, and tourism, rely on healthy ecosystems. Ecosystem services, such as carbon sequestration and shoreline protection, also rely on keeping the integrity and functionality of ecosystems. However, the ocean economy and other human activities also affect the ocean environment, with consequences on future benefits and services.

Pressures and threats result from various causes and the confluence of various drivers, such as population growth, poverty, increasing demand and unsustainable resource use, coastal development, conversion of habitats, destructive fishing, dumping of waste into the oceans, oil spills, sedimentation, eutrophication, and other environmental pressures impact the health of coastal and marine ecosystems. Water quality has been most affected by nutrient loads, contaminants originating from domestic sewage and industrial and agricultural chemicals, and plastics.

In 2010, a Working Group of institutional partners and experts, coordinated by the Intergovernmental Oceanographic Commission (IOC), developed an indicator-based methodology for assessment of LMEs. This section presents the results of the studies done under the Transboundary Waters Assessment Programme (TWAP).

The LMEs in the EAS region should be given the highest priority because of the diversity of life they support, and the potential destruction they face. Examples of major transboundary issues in Sulu-Sulawesi Marine Ecoregion, Yellow Sea LME, and Arafura-Timor Seas are shown in **Table 15.3**.

The LMEs have high risk levels, especially in terms of plastic waste (microplastics), nutrients, and loss of coral reefs (**Table 15.4**). The major economic activities that will be most affected are fisheries and tourism – the main source of income and livelihood in coastal communities.

Table 15.3: Major Transboundary Issues.

LME	Issues
Sulu-Sulawesi Seas	• Unsustainable exploitation of fish • Habitat loss and community modification • Climate change • Marine pollution • Freshwater shortage • Alien and invasive species
Yellow Sea LME	• Pollution and contaminants from industrial, agricultural and urban sources; • Eutrophication due to increased dissolved inorganic nitrogen and phosphorus; • Harmful algae blooms, when collapsed, causing oxygen depletion and consequent fish kills, and loss in mariculture; • Fishing efforts exceeding ecosystem carrying capacity; • Unsustainable mariculture with disease transmission and concentration of organic wastes; • Habitat loss where 40 percent of coastal wetlands have been converted to other uses; • Jellyfish bloom which causes clogging of fishing nets and affect recreational activities;

Table 15.3: Major Transboundary Issues. (cont.)

LME	Issues
	• Changes in biomass and composition of phytoplankton and zooplankton communities that could have serious consequences for fishery productivity (Commercially important long-lived, high trophic level, piscivorous bottom fish have been replaced by the low-valued shorted-lived, low trophic level, planktivorous pelagic fish); and • Climate change will affect the marine ecosystems in many ways, in particular the cold water mass overwintering by major commercial fish species located in the central southern part of the Yellow Sea.
Arafura – Timor Seas	• Unsustainable fisheries and decline and loss of living coastal and marine resources • Modification, degradation and loss of coastal and marine habitats • Marine- and land-based pollution (e.g., marine debris, sediments, oil spills) • Decline and loss of biodiversity and key marine species • Impacts of climate change, including ocean warming and ocean acidification

Table 15.4: Risks and Risk Levels in the LMEs.

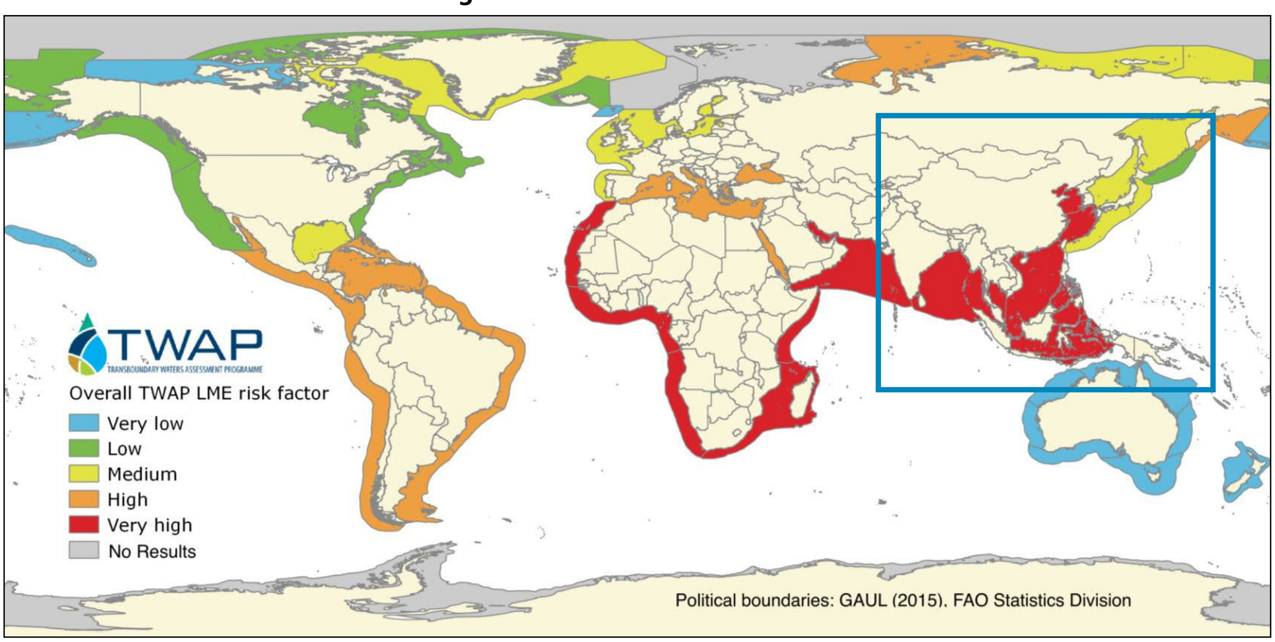
LME	Primary Productivity	Ecosystem Health	Nutrients		Plastic Waste		POPs		
	(Chlorophyll-A)	(Coral Reefs)	2000	2030	Micro	Macro	DDT	HCH	PCB
Bay of Bengal	High	Medium	Very High	Very High	Very High	Very High	Low	Low	Low
East China Sea	High	Very High	Very High	Very High	Very High	Very High	Medium	Very Low	Low
Indonesian Seas	High	High	Medium	Medium	Very High	Very High	Very High	Very Low	High
Gulf of Thailand	High	High	Very High	Very High	Very High	Very High	Medium	Very Low	Very Low
Kuroshio Current	Low	Very High	Medium	Medium	Very High	Very High	Medium	Very Low	High
Sea of Japan	Medium	no data	Medium	Medium	High	High	no data	no data	no data
South China Sea	Medium	Medium	Very High	Very High	Very High	Very High	High	Very Low	Medium
Sulu-Celebes Sea	Medium	Very High	Low	Medium	Very High	Very High	Low	Very Low	Medium
Yellow Sea	Very High	no data	High	High	Very High	High	Medium	no data	Very Low

Table 15.4: Risks and Risk Levels in the LMEs. (cont.)

LME	Sea Level Rise Threat		Climate Threat Index	Contemporary Threat Index
	Fragmented World Pathway	Sustainable Pathway	1993-2012	
Bay of Bengal	Very High	Very Low	Very High	Very High
East China Sea	Very High	Very Low	Very High	Very High
Indonesian Seas	Very High	Very Low	High	Very High
Gulf of Thailand	High	Very Low	Very High	Very High
Kuroshio Current	Medium	Very Low	Low	Medium
Sea of Japan	Medium	Very Low	Medium	High
South China Sea	High	Very Low	Very High	Very High
Sulu-Celebes Sea	High	Very Low	Very High	Very High
Yellow Sea	High	Very Low	Very High	Very High

* POPs - persistent organic pollutants
Source: UNESCO-IOC/GEF/UNEP TWAP 2015 (a-f).

Figure 15.3: Overall LME Risk.



Source: UNESCO-IOC/GEF/UNEP TWAP, 2015f.

15.2.1 Bay of Bengal Large Marine Ecosystem (LME 34)[250]

The Bay of Bengal Large Marine Ecosytem (BOBLME) covers the Bay of Bengal, Andaman Sea, Malacca Strait and the Indian Ocean (**Figure 15.4**). The BOBLME region includes the high seas, continental shelf, and coastal waters of Sumatra, Indonesia (Aceh province, Riau, North Sumatra, and West Sumatra); the western coast of Peninsular Malaysia; West coast of Thailand, Myanmar, Bangladesh; east coast of India; Andaman and Nicobar Islands of India; Sri Lanka; and Maldives. The bay and associated coastal systems cover approximately six million km^2.

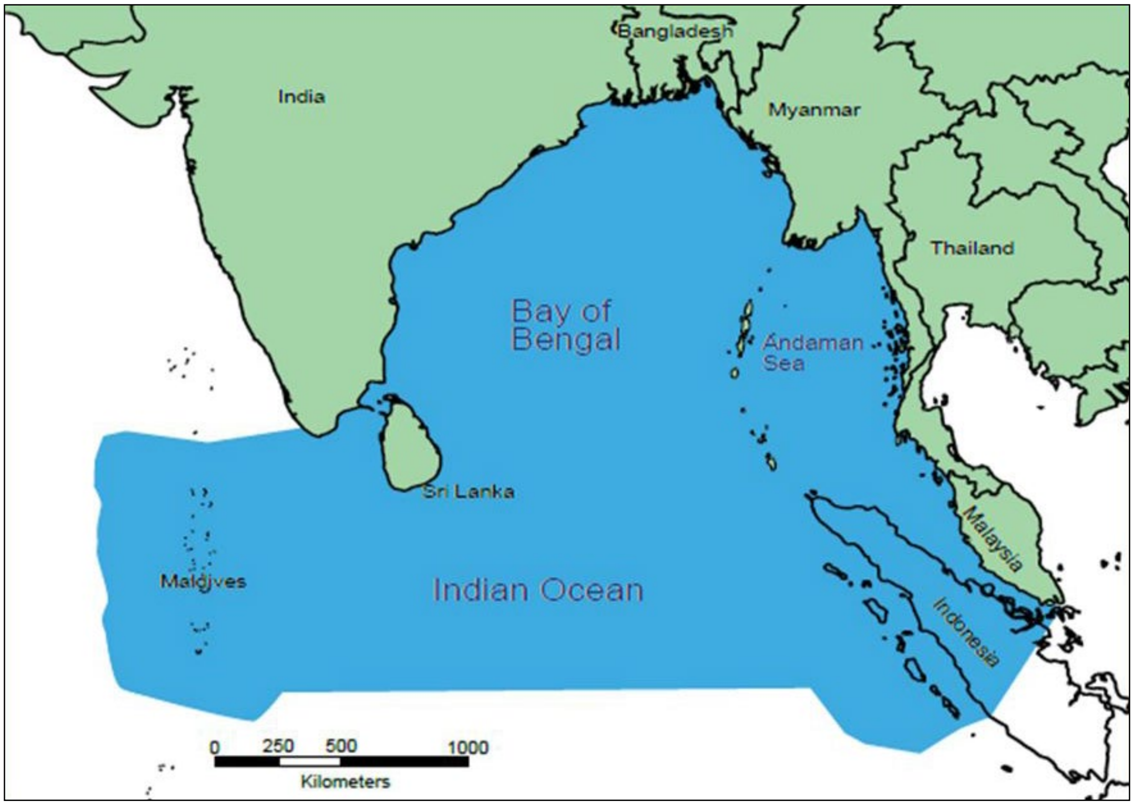
The countries involved in BOBLME programme are Indonesia, Malaysia, Thailand, Myanmar, Bangladesh, India, Sri Lanka and Maldives. Of the BOBLME area, 31.5 percent is high seas, while for the countries with the biggest area in the BOBLME are India (21.2 percent), Maldives (14.7 percent) and Indonesia (11.5 percent) (**Table 15.5**).

The Bay of Bengal is classed as a moderately productive ecosystem. Although it lacks the nutrient upwelling characteristic of some major LMEs, it is relatively well mixed by a combination of currents, tides, coastal currents, cyclones and storm surges. Inshore habitats in the inner part of the bay are dominated by estuarine habitat, brackishwater wetlands and mangrove. Further out can be found seagrass beds and coral reefs. BOBLME is home to 12 percent of the world's mangroves, and 8 percent of global coral reefs. These are of substantial importance to the functioning of the wider ecosystem, providing spawning and nursery areas for some fish and prawn species. Six areas are of substantial significance in terms of biodiversity: the Sundarbans, one of the world's most extensive mangrove systems; Palk Bay; the Gulf of Mannar; the Marine (Wandur) National Park in the Andaman and Nicobar Islands; the Maldives Atolls; and Mu Ko Similan National Park and Mu Ko Surin National Park in Thailand.

In its inner reaches, the BOBLME is heavily influenced by the inflow from the Ganges/Padma, Jamanu/Brahmaputra, and Irrawaddy River systems. These are all associated with large populations, major cities and intensive agricultural activity, resulting in significant nutrient inputs as well as chemical pollution.

[250] Information on BOBLME in this section comes from: (a) FAO, 2012.; (b) UNESCO-IOC/GEF/UNEP TWAP, 2015a; and (c) FAO, 2016.

Figure 15.4: Bay of Bengal Large Marine Ecosystem (BOBLME).



Source: FAO, 2012; Sea Around Us Project and the BOBLME RCU.

Table 15.5: Coastline and Area of EEZ in BOBLME.

Country	Coastline (km)	EEZ area (km²)	Percentage of area (%)
Bangladesh	710	78,540	1.3
India	4,645	1,326,510	21.2
Indonesia	~ 2,000	719,300	11.5
Malaysia	1,110	68,740	1.1
Maldives	n/a	916,190	14.7
Myanmar	3,000	520,260	8.3
Sri Langka	1,770	530,680	8.5
Thailand	740	118,600	1.9
High Seas	-	1,972,170	31.5
Total	**~ 14,000**	**6,251,000**	**100.0**

Source: FAO, 2012.

Ocean Health Index (OHI)

The OHI score of 62 for the Bay of Bengal LME scores below average compared to other LMEs. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. This LME scores lowest on food provision, coastal protection, tourism & recreation, and sense of place goals, while highest on artisanal fishing opportunities, coastal economies, and habitat biodiversity goals.

Transboundary issues

Based on the BOBLME Transboundary Diagnostic Analysis (TDA) report, there are three important transboundary issues to consider:

1. **Excessive utilization of marine biological resources**
   a. Main issues
      - Decrease in fish resources
      - Change of catch type composition
      - Domination of juvenile catch
      - Changes in marine biodiversity, especially the loss of rare and vulnerable species.
   b. Main transboundary issues
      - Many stocks (shared stocks) between BOBLME member states, including fish or larval migration.
      - Overlapping fishing jurisdictions, both legal and illegal
      - All States have difficulties in applying fisheries management, especially the ecosystem approach in fisheries management (EAFM).
      - BOBLME member countries contribute significantly to the global problem of the loss of rare and vulnerable species.
   c. Causes
      - High consumption demand for fish, including seeds and feed for cultivation
      - The catchment area is open access.
      - Government pressure to increase fish catch
      - Government subsidies, which are not feasible for fisheries
      - Increased catch effort, particularly from trawling and purse seine fishing gear
      - Ineffective fisheries management
      - Illegal fishing and destructive fishing
      - Most living marine resources are over-exploited because they are open access

2. **Damage of critical habitats**
   a. Main issues
      - Degradation and loss of mangrove habitat
      - Degradation of coral reefs
      - Damage and loss of seagrass beds
   b. Main transboundary issues
      - Critical habitats like mangroves, coral reefs and seagrass beds in all BOBLME member states
      - Coastal development for multiple land and sea utilization in all BOBLME member countries
      - Trade of products from all transboundary habitats
      - Impacts of climate change that occur in all BOBLME member countries

c. Causes
- Poor coastal communities need food security
- Coastal development planning gap.
- Increased trade in products from coastal habitats.
- Coastal development and industrialization.
- Ineffective MPAs and gaps in law enforcement.
- Upper regional development (upstream) impacts on water flow.
- Agricultural activities in the upstream areas are intensive.
- Increased tours.

3. Water quality and pollution

a. Main issues
- Carried pathogenic waste and organic loads
- Solid waste/marine waste.
- Increased nutrient input.
- Oil pollution.
- Persistent organic pollutants (POPs) and persistent toxic substances (PTSs)
- Sedimentation
- Heavy metals

b. Main transboundary issues
- Discharge of untreated or general problem of waste management; waste and organic extraction from the cross-border Ganges-Brahmaputra-Meghna River.
- Disposable plastic and fishing gear are carried across the state boundaries.
- High intake of nutrients from rivers intensify on a large scale across national borders.
- Differences in regulations and enforcement of laws between States are related to waste disposal of vessels that cross the borders of the State.
- POPs/PTSs and mercury,
- Sedimentation and heavy metal contamination at local level and cross-border dimension gaps.

c. Causes
- Excessive consumption, produced by everyone.
- Increased population density and urbanization of coastal communities.
- The limitations of the allocation of funds for waste management.
- Industrial migration to BOBLME member countries.
- Proliferation of small-scale industries.

Socioeconomic implications

- **Economic dependence on coastal ecosystems.** Fish protein accounts for 32 percent of the total animal protein consumption of the coastal population. This LME ranks in the very high-revenue category in fishing revenues. On average, LME-based tourism income contributes 15 percent to the national GDPs of the LME coastal states.

- **Coastal poor.** The indigent population makes up 25 percent of the LME's coastal dwellers. This LME places in the very high-risk category based on percentage and in the very high-risk category using absolute number of coastal poor

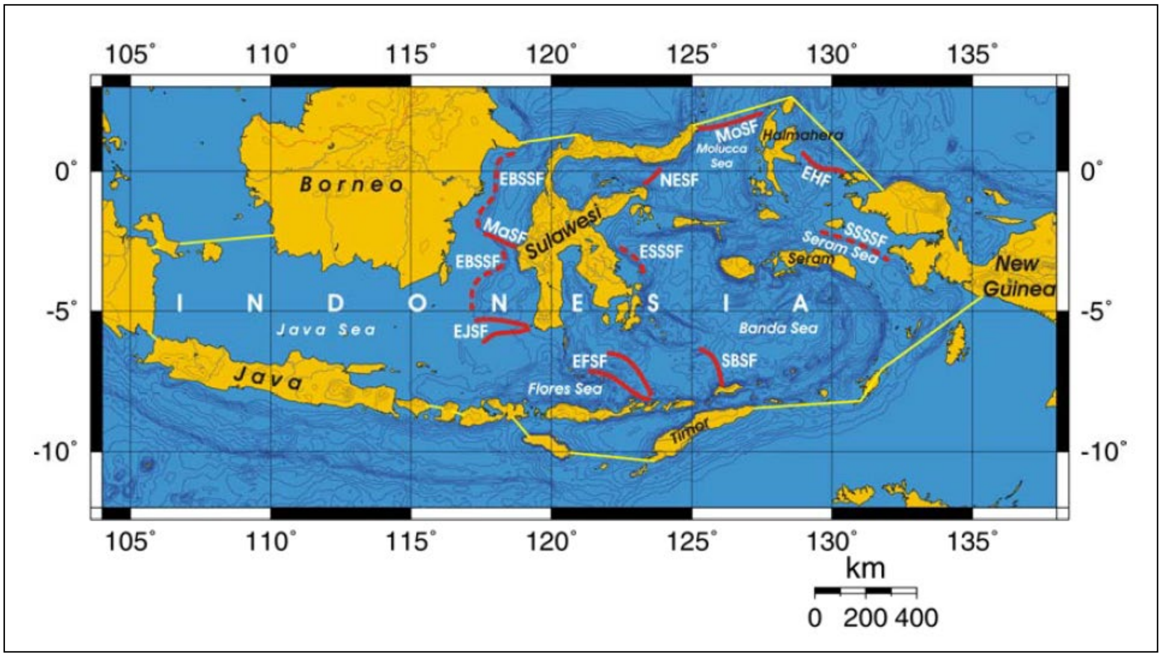
LME overall risk

This LME falls in the cluster of LMEs that exhibit low to levels of economic development (based on the night light development index) and high pollution from plastic debris. Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

15.2.2 Indonesian Sea Large Marine Ecosystem (LME 38)[251]

Indonesian Sea Large Marine Ecosystem (ISLME) is situated at the confluence of the Pacific and Indian Oceans, and it is bordered by Indonesia and Timor-Leste (**Figure 15.5**). The LME area covers 2,289.597 km^2, with 98 percent within Indonesia's territorial waters, and approximately 2 percent located within the territorial waters of Timor Leste. Geologically, the ISLME lies at the confluence of three tectonic plates: the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate.

Figure 15.5: Indonesia Sea Large Marine Ecosystem (ISLME).



Source: http:/www.lme.noaa.gov.

[251] Information on ISLME in this section comes from: UNEP/GIWA, 2005b;. and UNESCO-IOC/GEF/UNEP TWAP. 2015d.

The ISLME is globally important in terms of biodiversity, fisheries production (representing more than 1 percent of the global fisheries production), and global climate regulation, and considered as a Class I ecosystem with high productivity. Around 0.49 percent of this LME is covered by mangroves (US Geological Survey, 2011) and 1.13 percent by coral reefs (Global Distribution of Coral Reefs, 2010). The ISLME is located in the heart of the western Indo-Pacific marine biogeographical region, where species richness is greater than in any other location on Earth, supporting more than 500 species of reef-building corals, 2,500 species of marine fish, 47 species of mangroves and 13 species of seagrasses.

The ISLME has complex and rapid currents owing to energetic tides over rough topography and owing to the Indonesian Throughflow, which affects the global climate. A recently discovered climate feature, the Indian Ocean Dipole (IOD), is linked with fluctuations in sea surface temperature (SST) within the region.[252]

Within the ISLME, 1.49 percent of the area is officially protected. The ISLME experienced an increase in MPA coverage from 2,016 km^2 prior to 1983 to 75,423 km^2 by 2014. This represents an increase of 3,642 percent; however, this is still not enough to reach the Aichi Biodiversity Target of protecting at least 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, by 2020.

Ocean Health Index (OHI)

The Indonesian Sea LME score of 67 is below average compared to other LMEs. This score indicates that this LME is well below its optimal level of ocean health, although there are some aspects that are doing well. This LME scores lowest on mariculture, coastal protection, carbon storage, coastal livelihoods, tourism & recreation, and iconic species goals, while highest on artisanal fishing opportunities, and coastal economies goals.

Transboundary issues

1. Unsustainable exploitation of fish and other living resources

- The Stock-Catch Status Plots indicate that about 30 percent of the stocks in the LME are either overexploited or have collapsed, with 55 percent of the catch from fully exploited stocks.
- The percentage of catch from the bottom-impacting gear type to the total catch increased from 14 percent in the 1950s to its first peak at around 35 percent in 1980. Then, this percentage fluctuated between 16 percent and 20 percent in recent decade.

[252] UNEP/GIWA, 2005b.

2. **Pollution**
   - Modelled estimates of floating plastic abundance (items per km^2), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration. The abundance of floating plastic in this category is estimated to be on average over 400 times higher than other LMEs.
   - The risk level for nutrients (nitrogen load) is moderate (risk level is 3, on the scale of 1 to 5).
   - There are threats from oil and chemical spills in some areas.

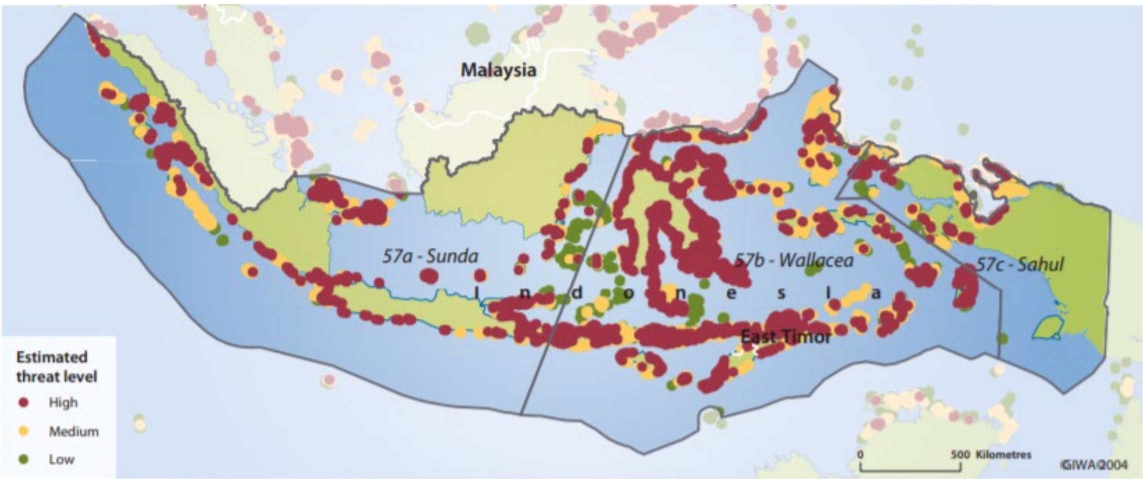
3. **Habitat modification.** In the ISLME as a whole, coral reefs and associated habitats of mangroves and seagrasses have experienced major declines in the past several decades. Around 15 percent of coral reef cover is under very high threat, and 27 percent under high threat (**Figure 15.6**). By year 2030, 34 percent of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification.

4. **Other key stressors.** Other key stressors include commercial shipping, ocean-based pollution, pelagic low-bycatch commercial fishing, and all three types of demersal commercial fishing (demersal destructive, non-destructive low-bycatch, and non-destructive high-bycatch).

Socioeconomic impacts

1. **Economic dependence on coastal ecosystems.** Fish protein accounts for 54 percent of the total animal protein consumption of the coastal population. This LME ranks in the high-revenue category in fishing revenues. On average, LME-based tourism income contributes 10 percent to the national GDP of Indonesia.
2. **Coastal poor.** The indigent population makes up 14 percent of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very high-risk category using absolute number of coastal poor.

Figure 15.6: Reefs at Risk in the Indonesian Sea LME.



Source: Burke et al., 2002; UNEP, 2005 (GIWA 57).

LME overall risk

This LME exhibits low levels of economic development (based on the night light development index) and high pollution from plastic debris. Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

15.2.3 South China Sea and Gulf of Thailand (LMEs 35 and 36)[253]

The South China Sea (SCS) is a very strategic water body for the surrounding nations, especially in terms of the rapid economic growth and industrialization of the Asia-Pacific region (Talaue-McManus, 2000). The South China Sea region contains nine nations; China, Viet Nam, Cambodia, Thailand, Malaysia, Singapore, Indonesia, Brunei and the Philippines (**Figure 15.7**). This Large Marine Ecosystem and its catchments are bounded to the west by the Mekong River (GIWA region 55), north by East China Sea (GIWA region 36), east by the Sulu-Celebes (Sulawesi) Sea (GIWA region 56) and Small Island States (GIWA region 62), and south and southeast by Indonesian Seas (GIWA region 57). The South China Sea is considered a semi-enclosed sea by the UN Convention on the Law of the Sea (UNCLOS): "A gulf, basin or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States" (Article 122 UNCLOS, 1982).

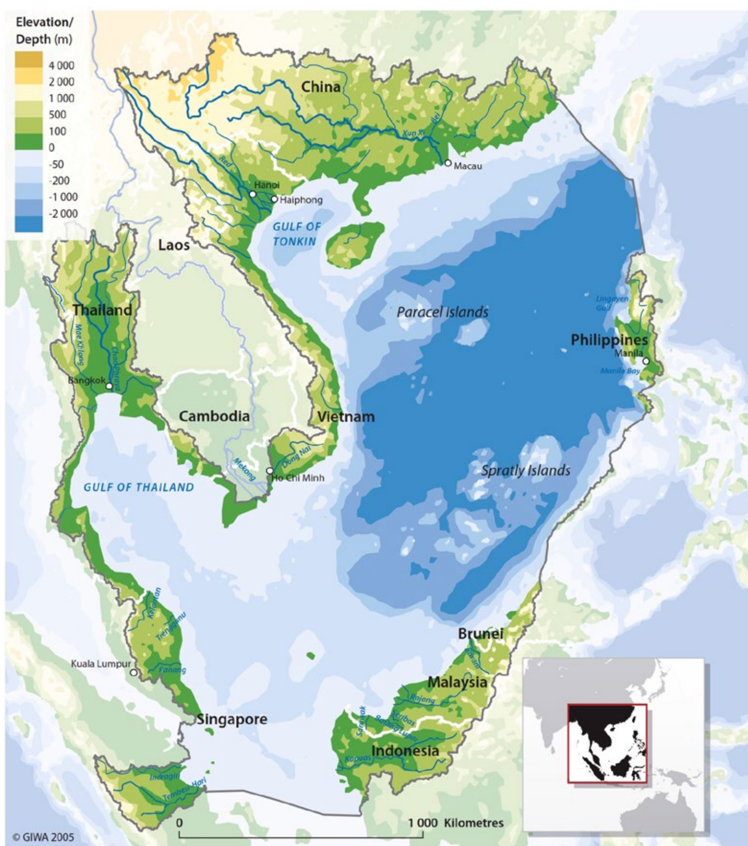


Figure 15.7:
South China Sea LME.

Source: UNEP, 2005. GIWA Regional Assessment 54.

[253] Information on South China Sea LME in this section comes from: UNEP/GIWA. 2005c; and UNESCO-IOC/GEF/UNEP TWAP 2015c.

The South China Sea LME lies within the global centre of biodiversity for marine species. The coastal area includes low-lying areas composed of sandy beaches and dune systems, mudflats, swamps and marshes, seagrass beds and mangroves and lake systems, to gravel/rocky coasts. Fringing coral reefs are developed in areas away from major rivers or areas of terrestrial run-off. There are approximately 125 major rivers in the South China Sea region, draining 2.5 million km^2. Six species of marine turtles, all considered either endangered or vulnerable by IUCN, exist, as does the dugong (*Dugong dugon*) and many other species of marine mammal also included on IUCN's Red List of Threatened Animals.

The South China Sea is also an area of great multilateral importance, being one of the world's busiest sea-lanes. The region spans the full gamut of economic activities, from subsistence agriculture and artisanal fisheries to light and heavy manufacturing and high technology industries.

Ocean Health Index (OHI)

The OHI score of 63 for South China Sea LME is below average compared to other LMEs. This score indicates that the LME is well below its optimal level of ocean health, although there are some aspects that are doing well. This LME scores lowest on food provision, coastal protection, carbon storage, tourism & recreation, sense of place, and clean waters goals, while highest on artisanal fishing opportunities.

Transboundary issues

The GIWA assessment in 2005 determined that the most severe environmental issues facing the South China Sea include: (a) suspended solids resulting from deforestation and agriculture in hundreds of watersheds; (b) habitat loss and modification, through massive deforestation and associated siltation, conversion to agriculture and other land uses (freshwater, coastal and estuarine habitats), and destructive fishing practices (coastal, estuarine and marine habitats); and (c) overexploitation and destructive fishing practices. Together with the TWAP report in 2015, the following risks and environmental and socio-economic impacts in this LME include:

1. **Pollution**
   - Suspended solids from deforestation and agricultural runoff
   - Very high nitrogen loading
   - POPs: Average concentrations ($ng.g^{-1}$ of pellets) were high for DDT (176, range 1-558 $ng.g^{-1}$), moderate for PCBs (97, range 8-757 $ng.g^{-1}$), and minimal for HCHs (1.2, range 0.2-208 $ng.g^{-1}$).
   - Plastic debris: Modelled estimates of floating plastic abundance (items per km^2), for both micro-plastic (<4.75 mm) and macro-plastic (>4.75 mm), indicate that this LME is in the group with the highest plastic concentration.

2. Habitat changes and loss

- Loss and fragmentation of mangrove forests from development, including massive conversion for aquaculture
- Loss and fragmentation of coral reefs from coastal development, sedimentation and destructive fishing (TWAP 2015 reported that: 12 percent of coral reefs cover is under very high threat, and 17 percent under high threat. By year 2030, 26 percent of coral cover in this LME is predicted to be under very high to critical level of threat from warming and acidification.)
- Loss and fragmentation of seagrass areas
- Reclamation of wetlands for urbanization, industry, and agriculture
- Habitat loss due to destructive fishing practices
- Conflicts among villagers and outside fishers
- Injuries to fishers
- Changes to market prices

3. Destructive fishing practices and overfishing

- The Stock-Catch Status Plots indicate that almost 40 percent of the stocks in the LME are collapsed or overexploited. Majority of the catches are supplied by fully exploited stocks.
- The percentage of catch from the bottom-impacting gear type to the total catch fluctuated between 12 and 24 percent from 1950 to 2010. This percentage fluctuated around 22 percent in the recent decade (2005-2015).

Socioeconomic impacts

1. Economic dependence on coastal ecosystems. Fish protein accounts for 28 percent of the total animal protein consumption of the coastal population. This LME ranks in the very high-revenue category in fishing revenues. On average, LME-based tourism income contributes 12 percent to the national GDPs of the LME coastal states.
2. Coastal poor. The indigent population makes up 14 percent of the LME's coastal dwellers. This LME places in the low-risk category based on percentage and in the very high-risk category using absolute number of coastal poor

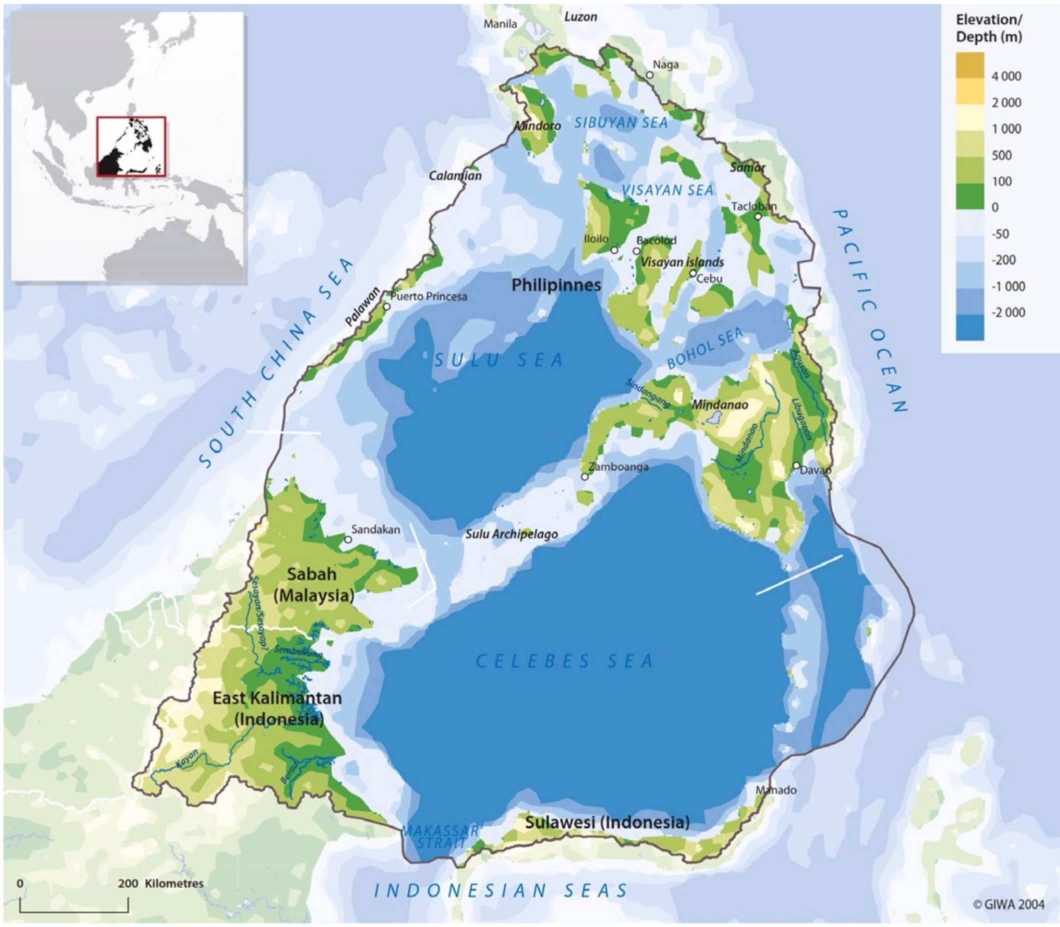
Overall risk level

This LME exhibits low level of economic development (based on the night light development index) and high pollution from plastic debris. Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

15.2.4 Sulu-Celebes (Sulawesi) Seas (LME 37)[254]

Sulu-Celebes Seas Large Marine Ecosystem is an integral part of the western Indo-Pacific region (Briggs, 1999). The Sulu-Celebes Seas LME, also called Sulu-Sulawesi Marine Ecoregion (SSME) and Sulu-Sulawesi Seascape (under the Coral Triangle Initiative) includes the Philippine Islands (including Southern Luzon, Northern and Eastern Samar, islands in the Visayas, and Mindanao east of Diuata Mountain), north of the Indonesian archipelago (Sangihe Islands, North Sulawesi and East Kalimantan), and Sabah, Malaysia (**Figure 15.8**).

Figure 15.8: Sulu-Celebes Sea LME Area.



Source: UNEP, 2005. GIWA Regional Assessment 54.

This region has complex oceanographic conditions, and long tectonic history. Spanning 900,000 km^2 of waters between Indonesia, Malaysia and the Philippines, the Sulu-Sulawesi Seascape provides food, shelter, livelihoods and recreation to 40 million people. The mangrove forests,

[254] Information on Sulu-Celebes (Sulawesi) Seas LME in this section comes from: UNEP/GIWA, 2005a, and UNESCO-IOC/GEF/UNEP TWAP, 2015c.

seagrass beds, and coral reefs that form its coastal ecosystems are rich and productive, as are its soft-bottom and pelagic environments. Being part of the Coral Triangle and at the heart of the most bio-diverse marine area in the world, with many species of global significance, this LME is also a very rich fishing ground for bay and coral reef fishes as well as large and small pelagic fish, providing livelihoods to the coastal inhabitants and food for the entire region and beyond. Reef fisheries provide essential sustenance to artisanal fishers and their families throughout the region while high value fish products are exported to expanding international, national as well as local markets. The fishery sources, however, have declined due to various threats. Increasing demand for fish from both international and local markets have resulted in depletion. At the same time, destructive fishing methods and gear have damaged reefs, stripped the seabed and depleted marine populations. Changes in land-use, urbanization, conversion, mining, reclamation, dredging, pollution, and siltation have destroyed coastal ecosystems.

Ocean Health Index (OHI)

The OHI score for Sulu-Celebes Sea LME is 62 (out of 100), which is below average compared to other LMEs. This score indicates that the LME is well below its optimal level of ocean health, This LME scores lowest on mariculture, coastal protection, carbon storage, coastal livelihoods, tourism and recreation, sense of place, and clean waters goals and highest on artisanal fishing opportunities.

Transboundary issues

The following key issues are considered to have the most severe transboundary environmental and socio-economic impacts in the region (TWAP, 2015):

1. **Unsustainable exploitation of living resources**
   - The Stock-Catch Status Plots indicate that about 27 percent of the stocks in the LME have collapsed or are currently overexploited, and that the reported landings are largely supplied – almost 70 percent – by fully exploited stocks.
   - The percentage of catch from the bottom-impacting gear type to the total catch decreased from 70 percent in the early 1950s to 12 percent in late 1950s. Then, this percentage fluctuated around 17 percent in recent decade.

2. **Habitat and community modification.**
   - 29 percent of coral reefs cover is under *very high* threat, and 34 percent under *high* threat. By year 2030, 61 percent of coral cover in this LME is predicted to be under *very high to critical* level of threat from warming and acidification
   - The Sulu-Celebes Seas LME experienced an increase in MPA coverage from 615 km^2 prior to 1983 to 27,582 km^2 by 2014. This represents an increase of 4,387 percent, within the medium category of MPA change.

3. **Pollution.** This LME has minimal risk from nutrient and POPs. However, this LME is in the group with the highest plastic concentration.

4. **Global climate change.** This LME is most vulnerable to climate change. Of the 19 individual stressors, three connected to climate change have the highest average impact on the LME: ocean acidification, UV radiation, and sea surface temperature.

5. **Other key stressors:** demersal destructive commercial fishing and demersal non-destructive high bycatch; pelagic low-bycatch commercial fishing, and demersal non-destructive low-bycatch commercial fishing, commercial shipping, ocean-based pollution, and sea level rise.

Socioeconomic implications

1. **Economic dependence on coastal ecosystems.** Fish protein accounts for 39 percent of the total animal protein consumption of the coastal population. Fishing and tourism depend on ecosystem services provided by LMEs. This LME ranks in the high-revenue category in fishing revenues. On average, LME-based tourism income contributes 12 percent to the national GDPs of the LME coastal states. Destructive fishing practices and loss of coastal and marine habitats will impact revenues from fisheries and tourism, which are the major sources of income and livelihoods in coastal communities.
2. **Coastal poor.** The indigent population makes up 25 percent of the LME's coastal dwellers in 2010. This LME places in the very high-risk category based on percentage, and in the very high-risk category using absolute number of coastal poor.

Overall risk level

According to TWAP (2015): "This LME exhibits low levels of economic development (based on the night light development index) and high pollution from plastic debris. Based on a combined measure of the Human Development Index and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high."

15.2.5 Yellow Sea (LME 48)[255]

The Yellow Sea is defined by the Chinese mainland to the west and the Korean Peninsula to the east (**Figure 15.9**). The Bohai Sea to the north drains into the Yellow Sea and to the south, the Yellow Sea connects to the East China Sea. Named for the yellowish sand – which originates from the Yellow River – that colors its water, the Yellow Sea is one of the largest shallow areas of continental shelf in the world. The floor of the Yellow Sea is post-glacially submerged portion of

[255] Information on the YSLME in this section comes from: UNDP 2020, and UNESCO-IOC/GEF/UNEP TWAP 2015e.

the continental shelf, characterized by shallow depths (44 m average depth and 100 m maximum depth), and a gently sloping seafloor within the YSLME project area.

Figure 15.9: Yellow Sea Large Marine Ecosystem.

Source: http://www.yslmep.org/?page_id=43

The Yellow Sea Large Marine Ecosystem (YSLME) is a water body bordered by China, RO Korea and DPR Korea, covering an area of 400,000 km^2. It is highly productive ecosystem, providing one million tonnes of capture fisheries and 14 million tonnes of mariculture per year. The major rivers flowing into the Yellow Sea are the Yangtze, Yellow, Han, Datung, Yalu, Guang, and Sheyang Rivers. These rivers discharge about 1.6 billion tons of sediment and 1,500 billion tonnes of freshwater into the Yellow Sea annually. The flushing rate between Yellow Sea and East China Sea is once every seven years. This low flushing rate combined with the weak water circulation makes this sea vulnerable to pollution and degradation.

According to WWF, the Yellow Sea supports dugong, Dall's and Harbor porpoises, leatherback, green, hawksbill and Ridley turtles as well as newly discovered species of goby fish.[256]

[256] European Space Agency, 2006. (https://www.esa.int/Applications/Observing_the_Earth/Earth_from_Space_The_Yellow_Sea_of_China)

Box 15.2. Tidal Flats and Migratory Birds

The southern part of the Yellow Sea, including the entire west coast of Korea, contains a 10 km-wide belt of intertidal mudflats, which has the total area of 2,850 km2. Those flats consist of highly productive sediments with a rich benthic fauna and are of great importance for migratory waders and shorebirds.[257] Surveys show that the area is the single most important site for migratory birds on northward migration in the entire **East Asian – Australasian Flyway**, with more than 35 species occurring in internationally significant numbers. Two million birds, at minimum, pass through at the time, and about half that number use it on southward migration.[258] About 300,000 migrating birds were transiting annually only through the Saemangeum tidal flat area, but this estuary was dammed by RO Korea in 1991–2006, resulting in drying off the land.[259] Land reclamation also took 65 percent of the intertidal area in China between the 1950s and 2002.[260]

Ocean Health Index (OHI)

The YSLME scores below average on the OHI compared to other LMEs (score 65 out of 100; range for other LMEs was 57 to 82). This score indicates that YSLME is well below its optimal level of ocean health, although there are some aspects that are doing well. Its score in 2013 increased 1 point compared to the previous year, due in large part to changes in the score for natural products.

The YSLME scores lowest on fisheries, coastal protection, carbon storage, tourism & recreation, lasting special places, and clean waters goals and highest on coastal livelihoods and economies. It falls in risk category 5 of the five risk categories, which is the highest level of risk (1 = lowest risk; 5 = highest risk).

Transboundary issues[261]

The following major transboundary environmental issues have been identified in the transboundary diagnostic analysis (TDA):

- pollution and contaminants from industrial, agricultural and urban sources;
- eutrophication due to increased dissolved inorganic nitrogen and phosphorus;
- harmful algae blooms, when collapsed, causing oxygen depletion and consequent fish kills, and loss in mariculture;

257 Schwartz, M.L., 2005.
258 Barter, M.A., 2002; Barter, M.A., 2005.
259 Saemangeum and the Saemangeum Shorebird Monitoring Program (SSMP) 2006–2008, Birds Korea.
260 Murray *et al.*, 2014.
261 UNDP, 2020.

- fishing efforts exceeding ecosystem carrying capacity;
- unsustainable mariculture with disease transmission and concentration of organic wastes;
- habitat loss where 40 percent of coastal wetlands have been converted to other uses;
- jellyfish boom which causes clogging of fishing nets and affect recreational activities;
- Changes in biomass and composition of phytoplankton and zooplankton communities that could have serious consequences for fishery productivity (Commercially important long-lived, high trophic level, piscivorous bottom fish have been replaced by the low-valued shorted-lived, low trophic level, planktivorous pelagic fish); and
- Climate change will affect the marine ecosystems in many ways, in particular the cold-water mass overwintering by major commercial fish species located in the central southern part of the Yellow Sea.

YSLME Phase II: The summary state of scientific knowledge of the YSLME provided by the NSAP reports prepared by PR China (C-NSAP) and RO Korea (K-NSAP) were reviewed in regional meetings to determine the priority transboundary issues and to develop an analysis of the primary, intermediate, and root causes for these problems. The revisions to the updated TDA were finalized during the YSLME 4th ICC meeting held in Jeju, RO Korea in November 2019. The analysis formed the basis for the updated SAP document. The primary transboundary issues for the updated TDA differ only slightly from the original transboundary issues identified in the original TDA. These are:

- Fishing effort exceeding ecosystem carrying capacity
- Unsustainable mariculture
- Pollution and contaminants
- Eutrophication
- Change in ecosystem structure
- Habitat loss and degradation
- Climate change

The TDA 2020 highlights microplastics, seasonal ocean acidification, broader range of climate change impacts, and changes in patterns of harmful algal blooms, possible increase in frequency of toxic algal blooms, and drifting macroalgae *Sargassum* as emerging issues to the YSLME that the updated SAP will need to respond in the next decade.

Socioeconomic implications

1. **Economic dependence on coastal ecosystems.** The YSLME ranks in the very high-revenue category in fishing revenues (based on yearly average total ex-vessel price of US$ 2013) at US$ 4042 million for the period 2001-2010. Fish protein accounts for 26 percent of the total animal protein consumption of the coastal population. Its yearly average tourism revenue for

2004-2013 of US$ 208,962 million (at US$ 2013 prices) places it in the very high-revenue category. On average, LME-based tourism income contributes 10 percent to the national GDPs of the YSLME coastal states.

2. **Coastal poor.** The indigent population makes up nine percent (9%) of the LME's coastal dwellers in 2010. This LME places in the very low-risk category based on percentage and in the very high-risk category using absolute number of coastal poor (present day estimate).

Overall risk level

This LME falls in the cluster of LMEs that exhibit medium to high numbers of collapsed and overexploited fish stocks, high levels of demersal non-destructive low bycatch fishing, as well as very high shipping pressure.

Based on a combined measure of the Human Development Index (HDI) and the averaged indicators for fish & fisheries and pollution & ecosystem health modules, the overall risk factor is very high.

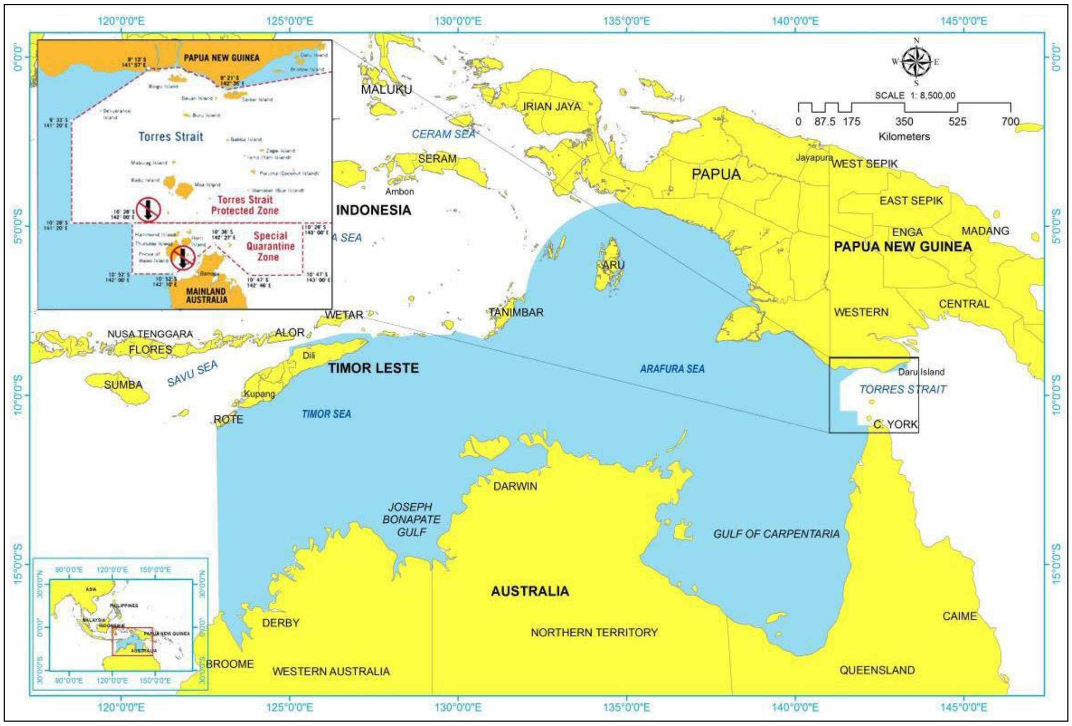
15.2.6 Arafura and Timor Seas

As the waters warm, the Arafura and Timor and Seas (ATS) region plays an important role in world ocean circulation, as it is situated between the Indian Ocean and the Pacific Ocean.[262] The world's climate is also greatly influenced by the El Niño-Southern Oscillation (ENSO) phenomenon and the Indian Pacific Warm Pool that exists in these seas. The ATS is a semi-enclosed sea under the UN Conventional of the Law of the Sea (UNCLOS) (**Figure 15.10**). It is bordered by Indonesia (Maluku, East Nusa Tenggara, and Papua), Papua New Guinea (South Fly district), Timor-Leste (11 districts) and Australia (Western Australia, Northern Territory, Queensland) There are four million people in the provinces/districts/States of the ATS region.

The ecosystems of ATS play an important economic and ecological role in the four littoral nations. This region is extremely rich in living and non-living marine resources, including major fisheries and oil and gas reserves. The high productivity in ATS sustains both small- and large-scale fisheries, including several high-value, shared transboundary fish stocks. The ATS region is adjacent to the Coral Triangle, which is considered to house the world's highest marine biodiversity. The ATS is part of an area designated the **North Australian Shelf Large Marine Ecosystem** (LME 39).

[262] Meyers, 1996, De Deckker *et al.*, 2003.

Figure 15.10: Arafura-Timor Sea Area.



Source: ATSEA, 2012.

Mangroves and freshwater and estuarine wetlands are a major feature of the sheltered, semi-enclosed waters of the ATS region. Indonesia (3, 112,989 ha) and Australia (977,975 ha) account for nearly 30 percent of the global area of mangrove forest.[263] The coastal regions of Indonesia, Papua New Guinea and Australia contain the highest levels of mangrove diversity with 45, 44 and 39 species recorded, respectively.[264]

Some of the largest areas of seagrass in the ATS region are recorded in the shallow, sheltered waters of the Arafura Sea and Gulf of Carpentaria. The estimated 13,425 km^2 to 17,500 km^2 of seagrass in Torres Strait has enabled the region to be a globally important dugong and green turtle habitat. Seagrasses in the Gulf of Carpentaria are less extensive than Torres Strait, covering about 900 km^2 of seabed in the 1980s. Within the ATS, 12 species of seagrass have been recorded for Indonesia waters, while 15 species of seagrass are recorded for northern Australia.

Due to the semi-enclosed nature of the ATS, coral reef development is largely restricted to the clearer waters of the offshore islands of eastern Indonesia (Nusa Tenggara Timur and Maluku region),[265] Timor-Leste,[266] and the edge of the continental margin of the northern Australian Shelf, the Sahul Banks,[267] and in the Torres Straits. In contrast, coral reefs along the southern coast of Papua are poorly developed due to high river flow and subsequent turbidity. In the Timor Sea,

[263] Giri *et al*., 2011.
[264] Spalding *et al*., 2010.
[265] Tomascik *et al*., 1997.
[266] Boggs *et al*., 2009.
[267] Heyward *et al*., 1997.

fringing coral reefs are found around the islands of Timor, Tikus, Burung, Kera, Semau, Kambing, Mera and Rote. The vast majority of the ATS is dominated by shallow shelf sediments and turbid waters – conditions unsuitable for reef development.

In recent decades, these seas have come under pressure from habitat loss, overfishing, and climate change. Further pressure is expected due to the presence of marine resources such as oil and natural gas. Regional transboundary management is needed to ensure the protected of economically and ecologically important resources. The Arafura and Timor Seas Ecosystem Action (ATSEA) Programme was launched in 2010.

Based on the TDA report for ATSEA, the major concerns are shown in **Table 15.6**.

Table 15.6: Transboundary Issues in Arafura and Timor Seas.

Priority Environmental Concerns	Key Causal Factors
1. Unsustainable fisheries and decline and loss of living coastal and marine resources	• illegal, unreported, and unregulated (IUU) fishing • overexploitation • unsustainable practices • fisheries by-catch
2. Modification, degradation and loss of coastal and marine habitats	• coastal development • bottom trawling • fuel wood (mangroves) • dynamite fishing • pollution (sediments)
3. Marine and land-based pollution (e.g., marine debris, sediments, oil spills)	• coastal development (nutrients, sediments) • mining (sediments, toxicants) • land degradation (sediments) • oil spills • marine debris
4. Decline and loss of biodiversity and key marine species	• illegal harvesting • traditional indigenous harvest • fisheries by-catch (ghost nets, trawling, long-lines) • habitat loss
5. Impacts of climate change including ocean warming and ocean acidification	• fossil fuel-based global energy consumption • land use • land use change and forestry

Source: ATSEA, 2012.

15.3 Major Risks in the LMEs[268]

15.3.1 Ecosystem Health

Decline in the health of marine ecosystems is already having severe consequences for the millions of people who depend on them for food, coastal protection, building materials and tourism, among

[268] The information and maps of LME risks in this section are from the UNESCO-IOC/GEF/UNEP Transboundary Waters Assessment Programme (TWAP) reports and LME Factsheets.

other goods and services. Marine ecosystems in general and coastal ecosystems in particular experience a wide range of stressors associated with human activities as well as natural changes.

Mangrove extent[269]

Mangroves provide at least US$ 1.6 billion each year in ecosystem services, including enhancing fisheries and filtering pollutants and contaminants from coastal waters and coastal protection from storms, floods and erosion. These habitats are also recognized as one of the key blue carbon habitats, capturing and storing carbon. Over the last century there has been extensive loss and degradation of mangrove habitats due to both human and natural pressures, such as coastal development, pollution, aquaculture, logging for timber and fuel wood, and sea level rise.

For the effective management and conservation of mangroves, baseline data on their extent and the threats they face is required to enable monitoring of changes over time and to inform management decisions. This first global baseline of mangrove extent by LME and the Western Pacific Warm Pool is based on the US Geological Survey's Global Distribution of Mangroves dataset.[270]

Globally, around 20 percent of total mangrove area has been lost between 1980 and 2005 due to a number of human activities, such as coastal development, aquaculture expansion and timber extraction. The impact of coastal development has widespread, and increasing, importance. The relative impact of climate change on mangroves is largely unknown, but it is predicted to increase in the future.

Coral reefs at risk[271]

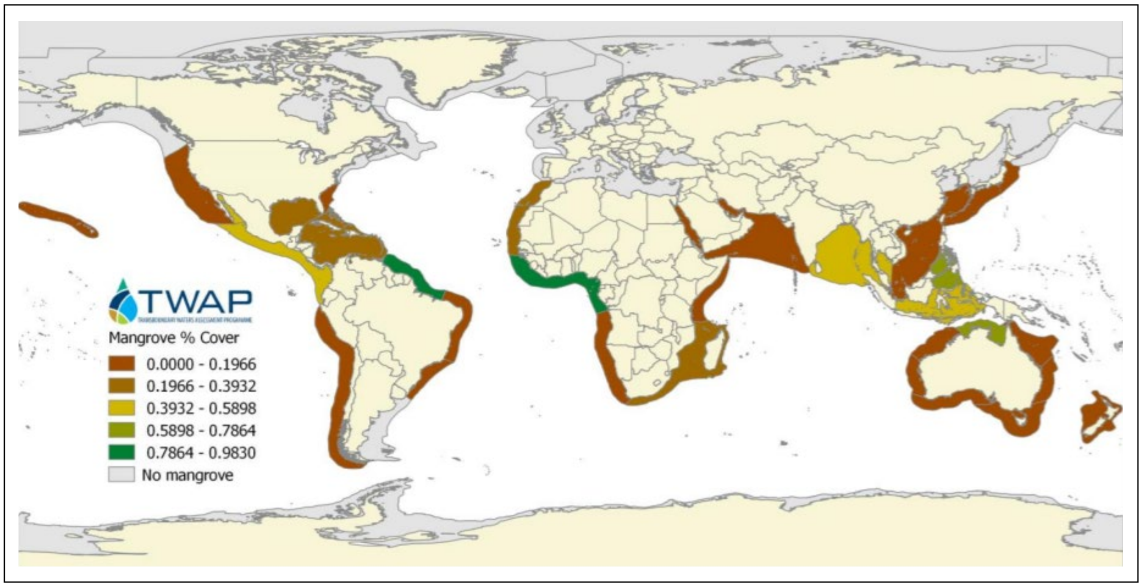
Coral reefs are some of the most economically valuable ecosystems on Earth, with their declines likely to have severe consequences for hundreds of millions of people who depend on them for food, coastal protection, building materials, and tourism. Coral reefs are one of the most endangered habitats on the planet, threatened by anthropogenic pressures such as warming waters, ocean acidification, pollution, overfishing, and extraction.

Global ocean warming and acidification will further increase the threats faced by coral reefs in the future. Multiple local threats likely reduce the ability of coral reefs to respond and adapt to ocean warming and acidification. Projected increases in these threats may impact human societies through changes in fishery resources, tourism and coastal protection. The extent of this negative impact will depend on the resilience of coral reefs to predicted threats as well as the implementation of measures to manage and protect coral reefs and their associated biodiversity.

269 Miranda Jones Jan-Willem van Bochove, Simon Blyth, Emma Sullivan and Chris McOwen in UNESCO-IOC/GEF/UNEP TWAP 2015f.
270 Giri *et al.*, 2011.
271 Miranda Jones Jan-Willem van Bochove, Simon Blyth, Emma Sullivan and Chris McOwen in UNESCO-IOC/GEF/UNEP TWAP 2015f.

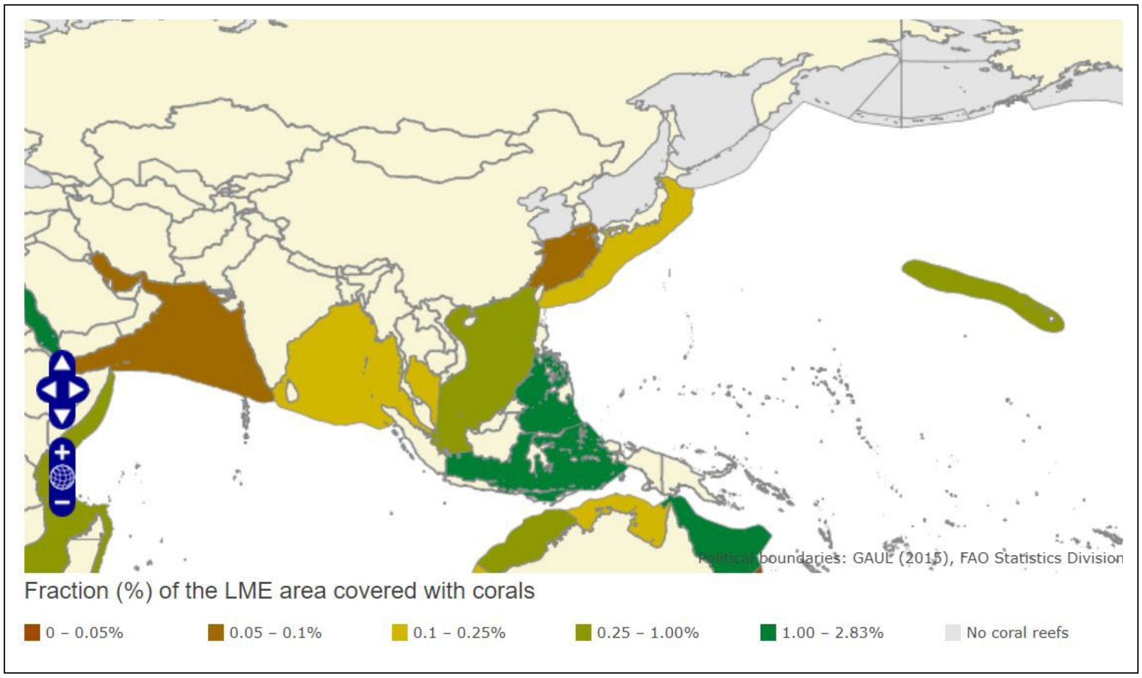
Implementing measures, such as MPAs, may enhance ecosystem resilience in the face of increasing global threats, while monitoring coral reef health is important to assess the actual impact to this threatened ecosystem from both local and global threats.

Figure 15.11: Mangrove Extent.



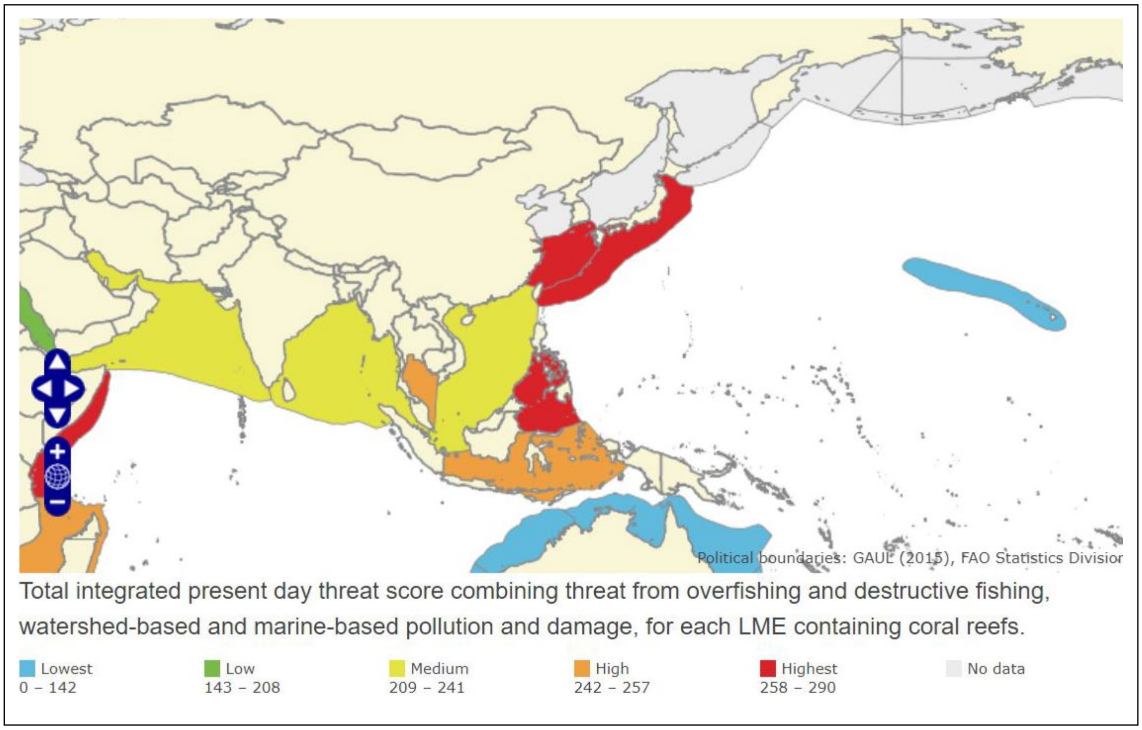
Extent of mangrove habitat, as percentage (%) of LME cover.
Source: UNEP-WCMC.

Figure 15.12: Coral Reefs Cover.



Source: UNEP-WCMC.

Figure 15.13: Reefs at Risk.



Source: UNEP-WCMC.

Change in extent of MPAs[272]

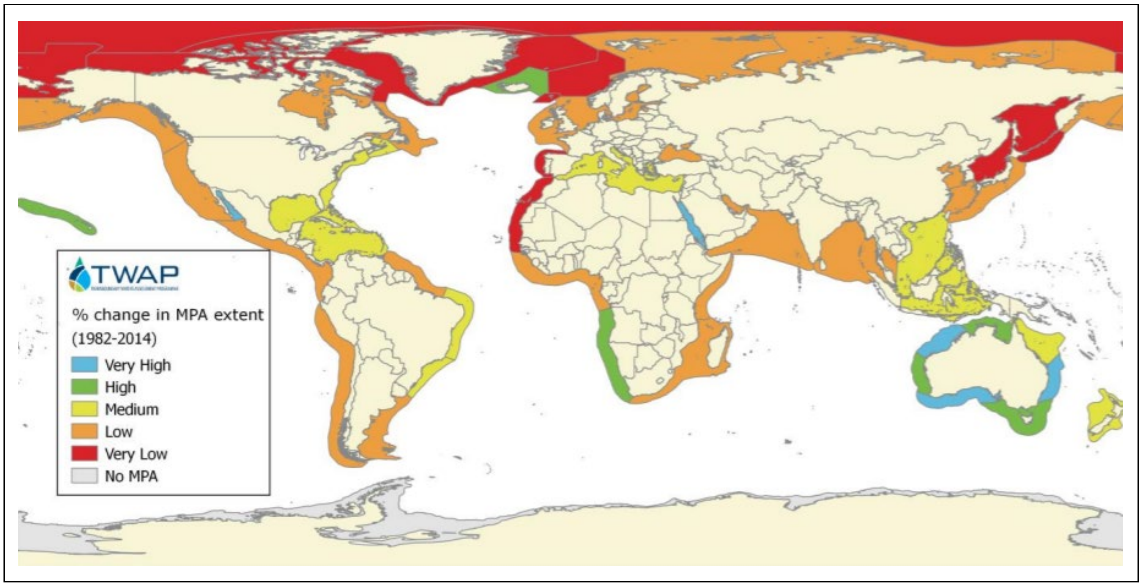
MPAs are vital to conserve the ocean's biodiversity and productivity. Aichi Target 11 of the Convention on Biological Biodiversity (CBD) aims to effectively conserve 10 percent of the world's coastal and marine areas by 2020.

The first estimates of the change in extent of the world's MPAs (between 1983 and 2014) for LMEs and the Western Pacific Warm Pool are presented, using data from the latest version (2014) of the World Database on Protected Areas (available at www.protectedplanet.net). Coverage of protected areas with marine components has increased from 340,230 km^2 in 1982 to 5,161,225 km^2 in 2014, with the greatest increases observed in the Australian Shelf Seas LMEs.

The continued designation of MPAs between 1983 and 2014 has led to a 15-fold increase in global MPA coverage. The increase in global MPA coverage indicates progress towards Aichi Target 11 of the CBD (although the global target was not met by 2020). The global distribution of MPA coverage indicates areas where potential threats to marine biodiversity may be reduced by further implementation of MPAs. This analysis does not provide an assessment of the likely effectiveness of the MPAs, as countries may vary in their interpretation and classification of particular types of MPAs and the degree of implementation and enforcement may vary.

[272] Miranda Jones, Simon Blyth and Chris McOwen in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.14: MPA Extent Change.



Change in MPA coverage (%) between 1982 and 2014.
Source: UNESCO-IOC/GEF/UNEP TWAP, 2015f.

15.3.2 Pollution

Marine and land-based pollution is of major concern in many LMEs. Pollution is often transboundary as hydrological interlinkages between river basins, marine ecosystems, and the atmosphere often result in effects far from the source of the emissions. The risk of transboundary impacts tends to be highest particularly for substances that readily migrate between water and air (such as DDT and mercury).

In many coastal areas, pollution and eutrophication have been important driving forces of change. Under the pollution sub-module, three major issues were assessed: floating plastic debris, the concentration of Persistent Organic Pollutants (POPs) in beached plastic resin pellets, and nutrient input to coastal areas from watersheds. These substances can affect the ecological status of marine ecosystems, impairing their health and that of living marine resources, and, in some cases, can result in harmful consequences for humans. Increase in the use of plastics, use of persistent chemicals including pesticides, and application of agricultural fertilizers and release of untreated sewage, among others, have resulted in high levels of these substances in some LMEs, especially with high coastal human populations (UNESCO-IOC/GEF/UNEP TWAP).

Nutrients[273]

Excess nutrients—nitrogen (N), phosphorus (P), silica (Si)—entering coastal waters (eutrophication) can result in algal blooms, leading to reduced oxygen conditions, increased turbidity, and changes

[273] The information on nutrients in this section is from: Sybil P. Seitzinger and Emilio Mayorga in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

in community composition, among other effects. Some of these blooms can be toxic to human and marine life and impair ecosystem health. Among the major anthropogenic sources of river nutrient loading to LMEs are runoff from fertilizer use and livestock production, sewage, and atmospheric nitrogen deposition.

- In many watersheds around the world river nutrient loads are projected to increase in the future due to further increase in human activities. The risk for coastal eutrophication will increase in twenty-one percent of LMEs by 2050 based on "current trends". Most of the increase is in LMEs in **southern and eastern Asia**, but also some in South America and Africa.
- As illustrated in the **BOBLME**, there can be considerable variation in the nutrient loads and sources as well as in eutrophication potential among the various river basins within an LME. This kind of information is important in identifying the spatial variation of nutrient effects and their sources for reduction within LMEs.
- To reduce current and future risk, reductions in nutrient inputs to specific watersheds are required. This can include, for example, increased nutrient-use efficiency in crop production, reduction in livestock and better management of manure, and increase treatment level (increased N and P removal) of human sewage.

The nutrient risk (2030 projection) is *highest* in the Bay of Bengal, East China Sea and South China Sea LMEs, and *high* in the Yellow Sea LME (**Figure 15.17**).

Plastics[274]

Floating plastic is now ubiquitous in the global ocean, including the remotest parts of the Southern Ocean, as a result of the durability of plastic and the overall ocean circulation. The occurrence of plastic in an LME may be due to sea- and land-based activities. A proportion of the plastic entering an LME is likely to be transported by wind and currents into an adjoining LME or the Open Ocean, making plastic pollution a classical transboundary issue. Larger plastic debris can have a significant impact on marine organisms, mainly due to entanglement and ingestion. Plastic can also cause major economic loss and pose a threat to navigation and human safety.

The risk level for microplastics is *highest* in the Bay of Bengal, East China Sea, Indonesian Seas, South China Sea, Sulu-Sulawesi Seas, and Yellow Sea LMEs, and *high* in Sea of Japan LME.

The risk level for macroplastics is *highest* in the Bay of Bengal, East China Sea, Indonesian Seas, South China Sea, and Sulu-Sulawesi Seas LMEs, and *high* in Yellow Sea and Sea of Japan LMEs.

[274] The information on nutrients in this section is from: Peter J. Kershaw and Laurent C.-M. Lebreton in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

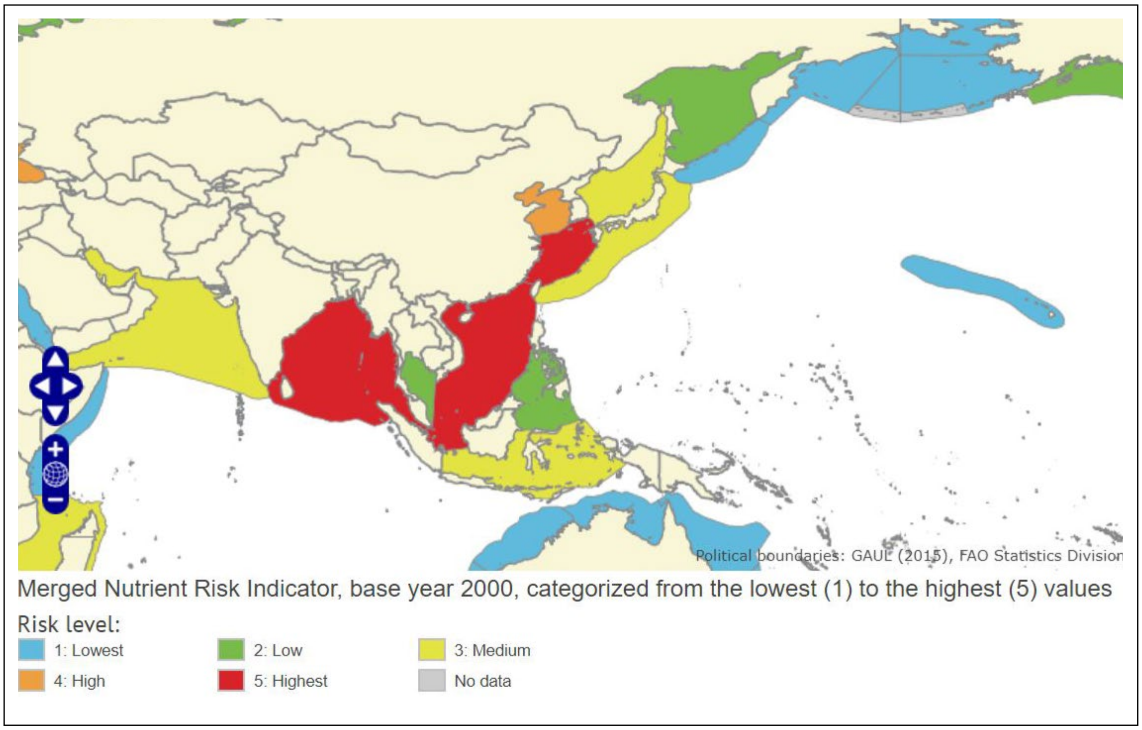
Persistent organic pollutants (POPs)[275]

Persistent organic pollutants (POPs) are used in industrial and agricultural applications, and not only are they persistent, they are also bioaccumulative and toxic. They are regulated by the Stockholm Convention on POPs. Three classes of POPs were assessed: polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethylene and its metabolites (DDTs), and hexachlorocyclohexane isomers (HCHs).

Plastic resin pellets were used as passive samplers of POPs in coastal waters. The pellets are found stranded on beaches all over the world. Within each LME, POPs levels were highly variable, and POPs were detected in all the samples including from remote islands. Several LMEs showed relatively high contamination levels (higher than category 3) for multiple POPs and a number of hotspots (categories 4 and 5) were found.

For DDTs, the risk level is *highest* in the Indonesian Sea LME, and *high* in South China Sea LME. For PCBs, the risk level is *highest* in the Indonesian Sea LME.

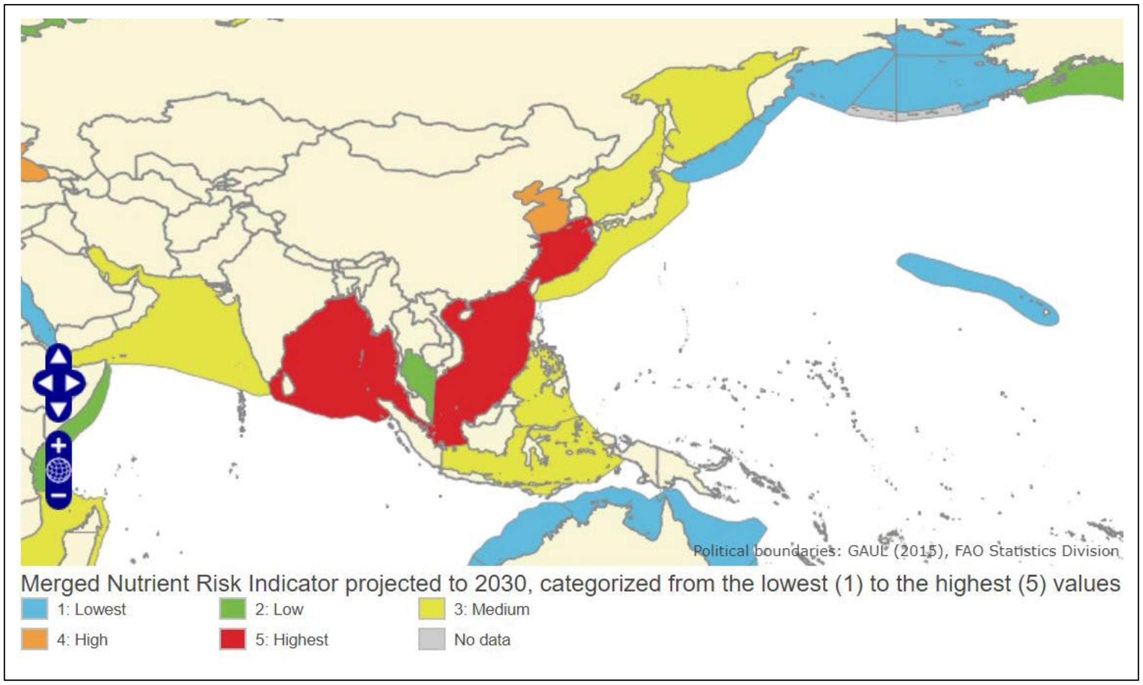
Figure 15.15: Nutrients: Base Year 2000.



Source: S. Seitzinger (IGBP) and E. Mayorga (Univ Washington/APL) in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

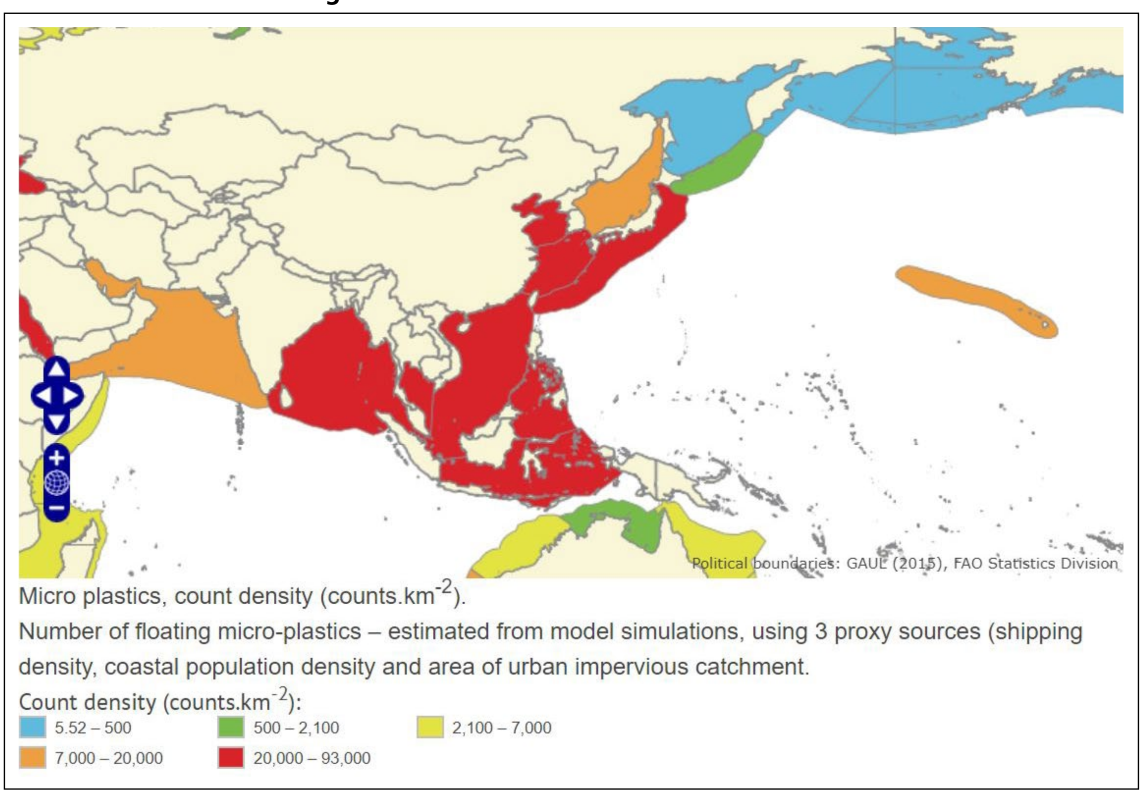
[275] The information on nutrients in this section is from: Hideshige Takada in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.16: Nutrients: Projected to 2030.



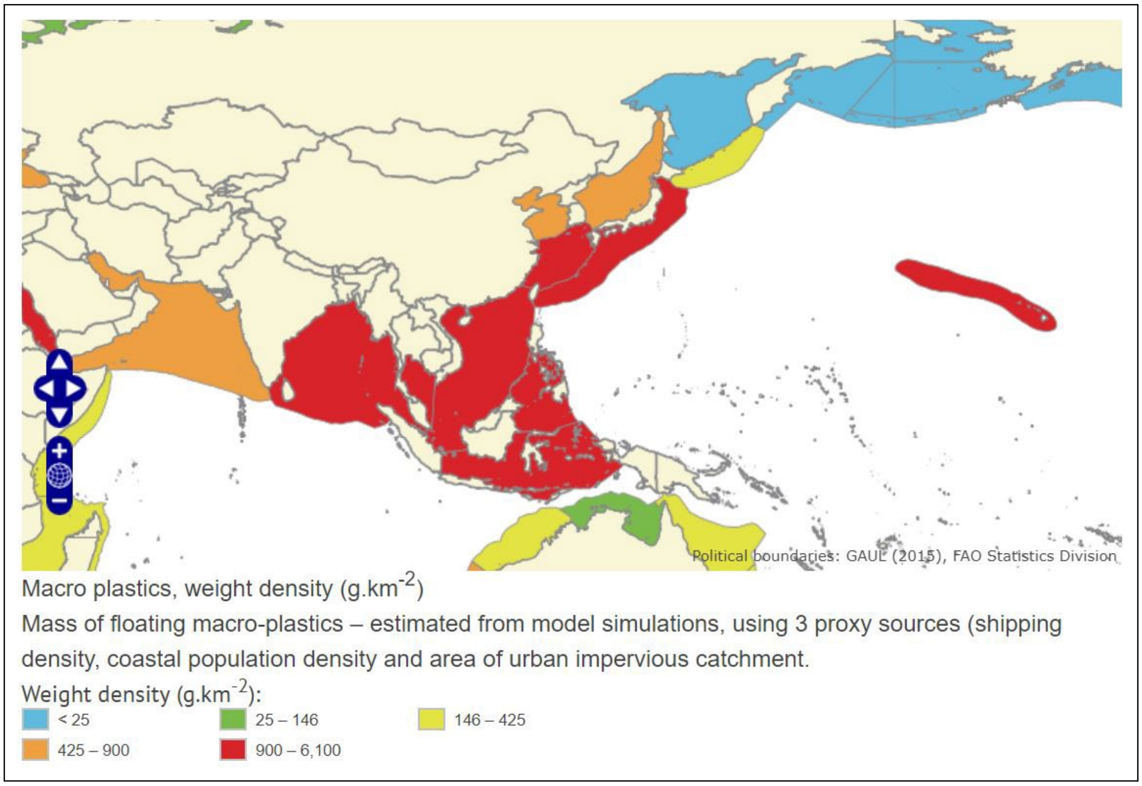
Source: S. Seitzinger (IGBP) and E. Mayorga (Univ Washington/APL) in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.17: Plastic Waste: Micro Plastics.



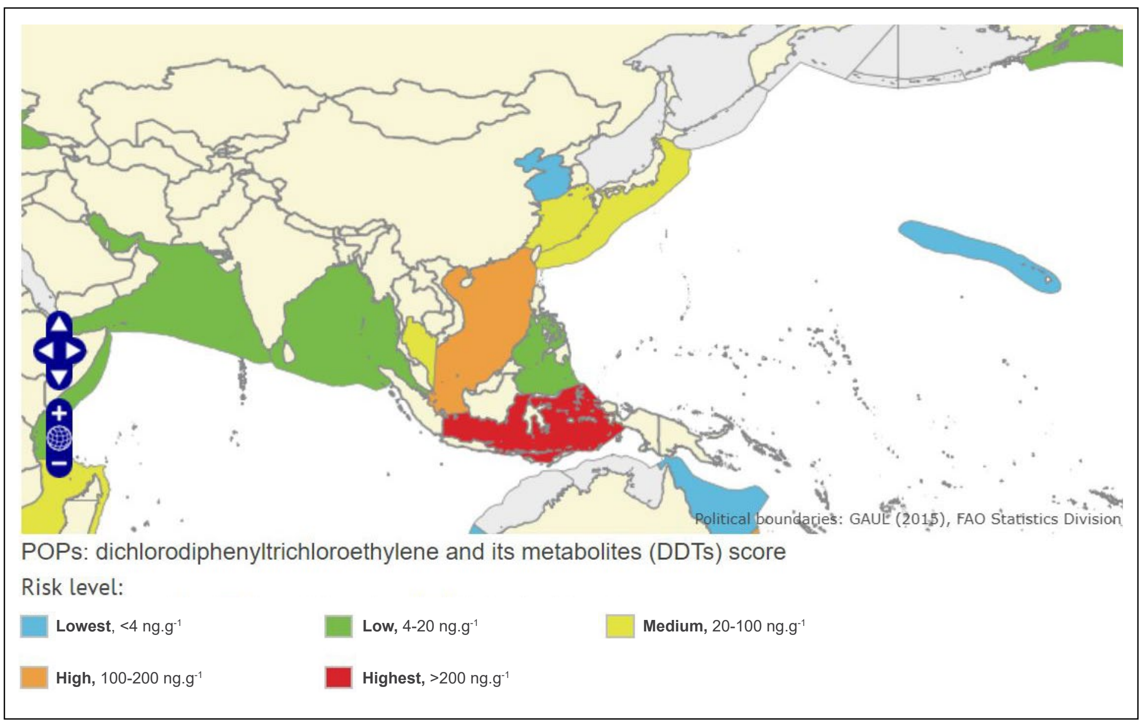
Source: L. Lebreton in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.18: Plastic Waste: Macro Plastics.



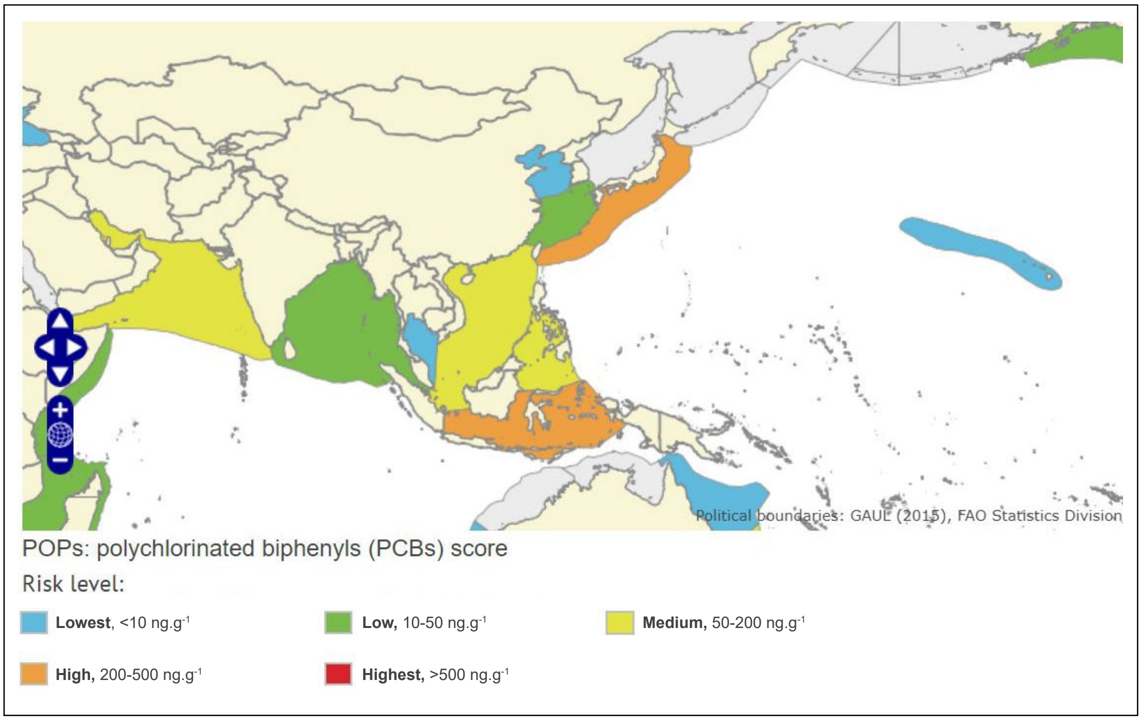
Source: L. Lebreton in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.19: Persistent Organic Pollutants (POPs): DDTs.



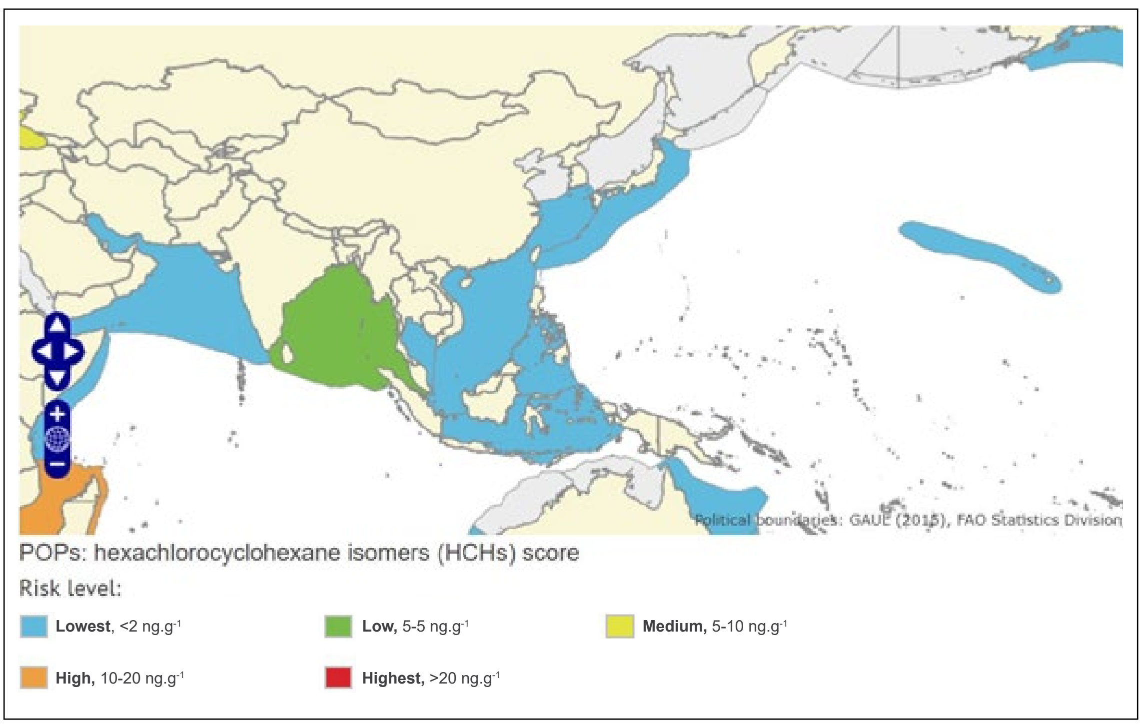
Source: Hideshige TAKADA (Tokyo University of Agriculture and Technology) in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.20: Persistent Organic Pollutants (POPs): PCBs.



Source: Hideshige TAKADA (Tokyo University of Agriculture and Technology) in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.21: Persistent Organic Pollutants (POPs): HCHs.



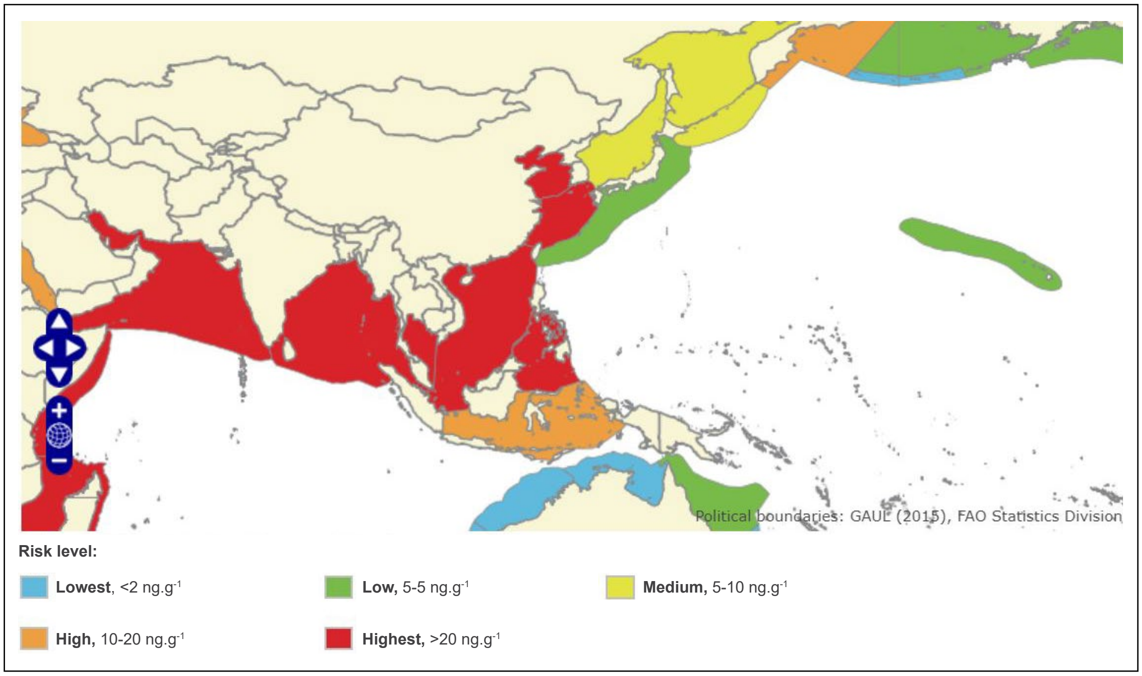
Source: Hideshige TAKADA (Tokyo University of Agriculture and Technology) in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

15.3.3 Climate Change Threats

The contemporaneous Climate Threat Index (1993-2012) takes into account the mortality and property losses due to flooding, storms, and extreme temperatures (such as extreme heat and cold events, prolonged drought).

The Indonesian Sea LME is at *high* risk, while the East China Sea, South China Sea and Gulf of Thailand, Sulu-Sulawesi Seas, and Yellow Sea LMEs are at *highest* risk from climate change (**Figure 15.22**).

Figure 15.22: Climate Change Index (Present Day).



Source: Liana McManus in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Sea Surface Temperature[276]

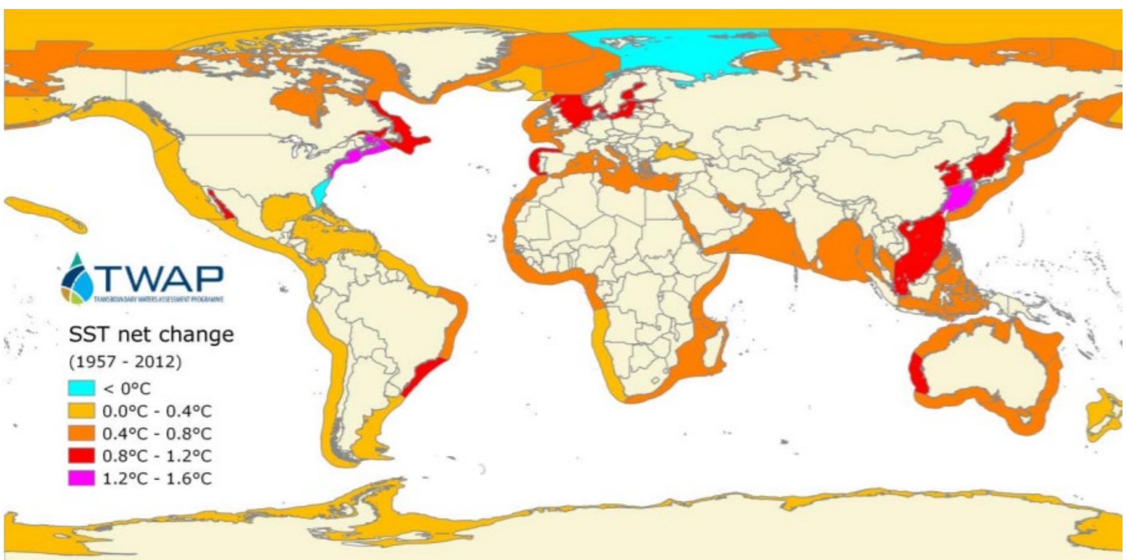
Global warming is already having major effects on marine ecosystems, although there is no direct link between potential ecological risks and sea surface temperature (SST) trends. SST is the only oceanic variable measured worldwide since the 19th century, providing the longest instrumental record of ocean climate change. Long-term consequences of global warming will be LME-specific, and therefore regional estimates and forecasts of SST warming/cooling rates are especially important. The United Kingdom Met Office Hadley Centre global climatology allowed construction of long-term SST time series (1957 to 2012) in the 66 LMEs and the Western Pacific Warm Pool.

[276] The information on nutrients in this section is from: Igor M. Belkin in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Key messages:

- Between 1957 and 2012, all except two LMEs warmed, with three regions warming very fast: Northwest Atlantic off the U.S.-Canada Northeast; Eastern North Atlantic: European Seas; and East/Southeast Asian Seas. The East China Sea LME warmed at the maximum rate.
- For many LMEs, the ongoing warming is beneficial, while it is detrimental to other LMEs. The global warming signal can affect marine biota directly, as it translates down to the ocean-scale, basin-scale, and LME-scale signals that affect relevant ecosystems through ambient temperature.

Figure 15.23: Sea Surface Temperature Change.



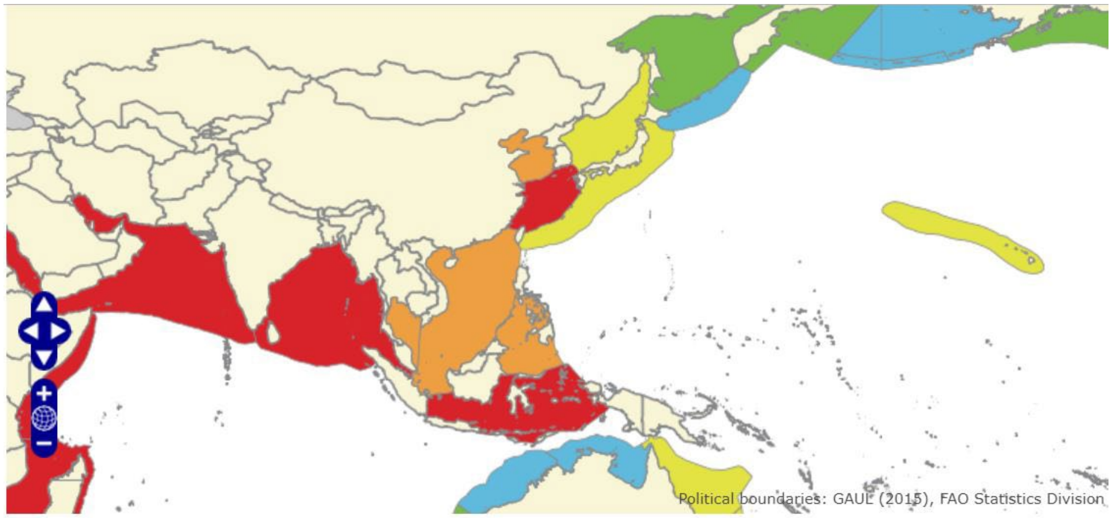
Source: UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Sea Level Rise Threat

In a *sustainable* scenario with low population growth rates, threat scores from exposure to sea level change ranges from 10-54 percent with a median of 31 percent. In a *high population growth rate* scenario, the median threat score increases significantly to 56 percent, with a range of 20-78 percent (UNESCO-IOC/GEF/UNEP TWAP, 2015f). Larger population sizes and wider gaps in HDI in the latter development mode both cause threat levels to increase under the same conditions of sea level rise.

In a **fragmented world pathway**, the Indonesian Sea LME, Bay of Bengal LME and East China Sea LME are at *very high* risk from the sea level rise, while the Sulu-Sulawesi Seas, South China Sea, and Yellow Sea are at *high* risk (**Figure 15.24**). On the other hand, all LMEs in the EAS region will be at low risk from sea level rise if the **sustainable pathway** (**Figure 15.25**) is followed (UNESCO-IOC/GEF/UNEP TWAP, 2015f).

Figure 15.24: Fragmented World Pathway.



Sea Level Rise Threat Index 2100 (Fragmented World Pathway SSP3)

For the 2100 sea level rise threat indices at sustainable development and fragment world development pathways, only the projected maximum sea level change data at RCP 8.5 scenario for 2100 was available and taken into account in the absence of projected data on flooding, storms and extreme temperature-caused mortality and damages for the same year.

Risk level:

Lowest | Low | Medium
High | Highest | No data

Source: Liana McManus in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

Figure 15.25: Sustainable Pathway.

Sea Level Rise Threat Index 2100 (Sustainable Pathway SSP1)

For the 2100 sea level rise threat indices at sustainable development and fragment world development pathways, only the projected maximum sea level change data at RCP 8.5 scenario for 2100 was available and taken into account in the absence of projected data on flooding, storms and extreme temperature-caused mortality and damages for the same year.

Risk level:

Lowest | Low | Medium
High | Highest | No data

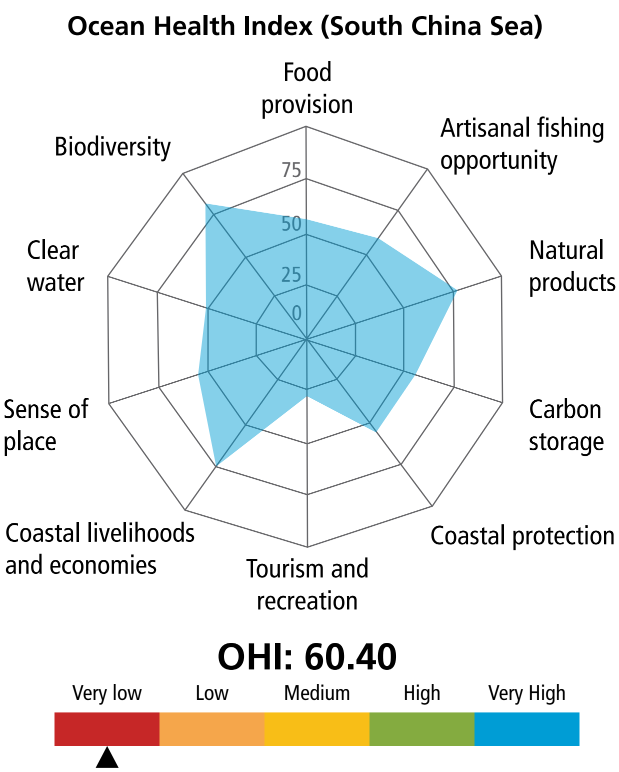
Source: Liana McManus in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

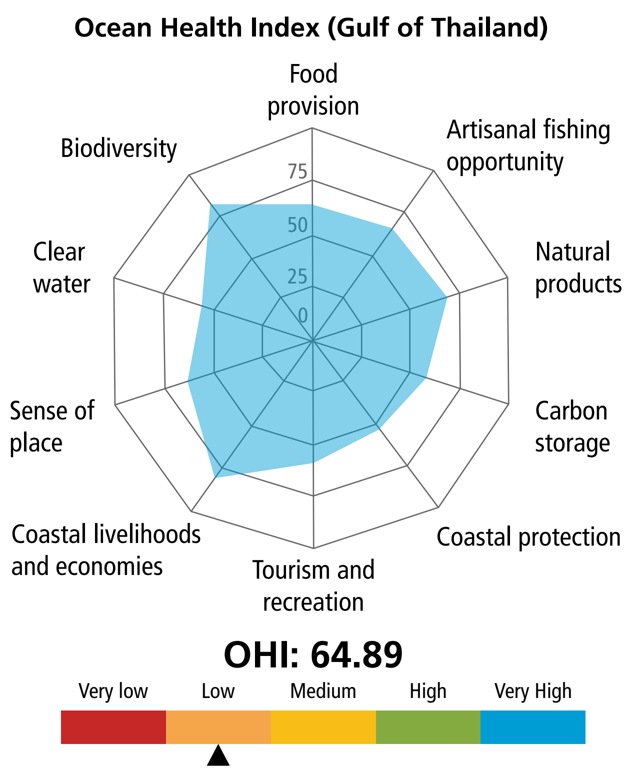
15.4 Ocean Health Index (OHI) of the LMEs[277]

People value ocean ecosystems for the many benefits they provide, such as food, aesthetic beauty, supporting livelihoods, and the vast diversity of species within them. Coastal regions are extremely productive, contain a vast majority of marine species, house the coastal habitats that protect our shores and sequester carbon, and are where a majority of people on the planet live, work and play.[278] LMEs represent the confluence of these values. To fairly assess the health of LMEs, one must therefore measure the status of all of the benefits provided by coastal marine ecosystems. The OHI measures the performance of 10 widely-held public goals for healthy oceans, including food provision, carbon storage, coastal livelihoods and economies, and biodiversity. Each goal is assessed against an ideal state, defined as the optimal and sustainable level that can be achieved for the goal. Extensive details on how each goal is measured and the data used to calculate the goal scores are provided in Halpern and others (2012), at www.ohi-science.org. OHI scores for the 66 LMEs ranged from 57 to 82 out of 100 (average 70.6).

The OHI scores of the LMEs in the EAS Region range from *Very Low* to *Low* and are below the global average (**Figure 15.26**). Thus, more efforts are needed to to ensure healthy ocean.

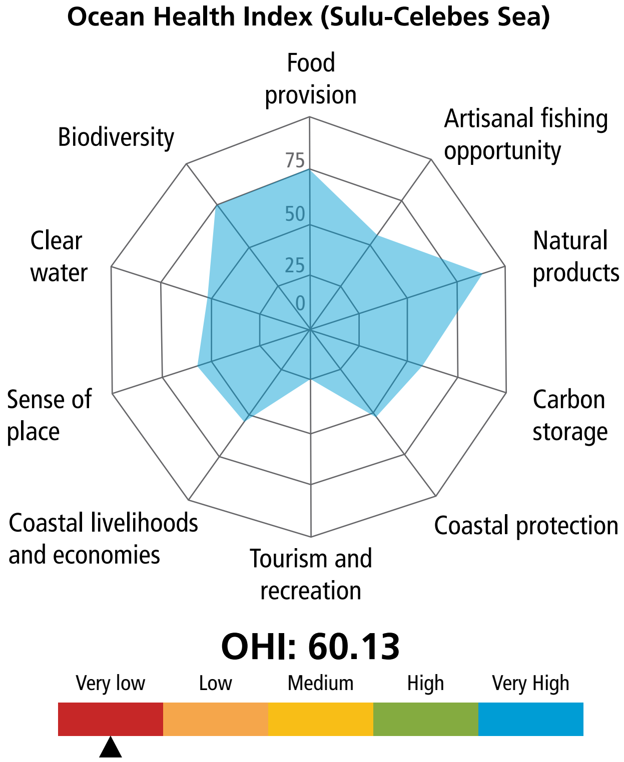
Figure 15.26: OHI Scores of the LMEs in the EAS Region.

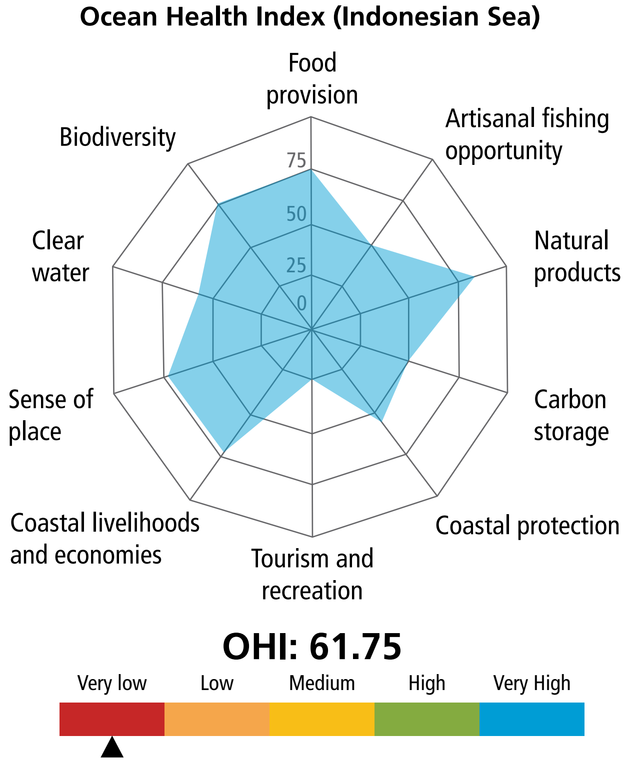


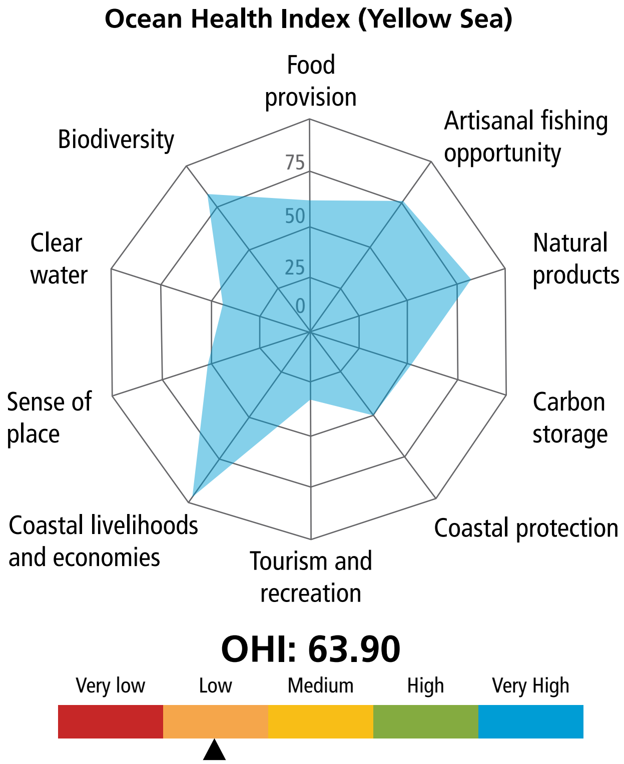


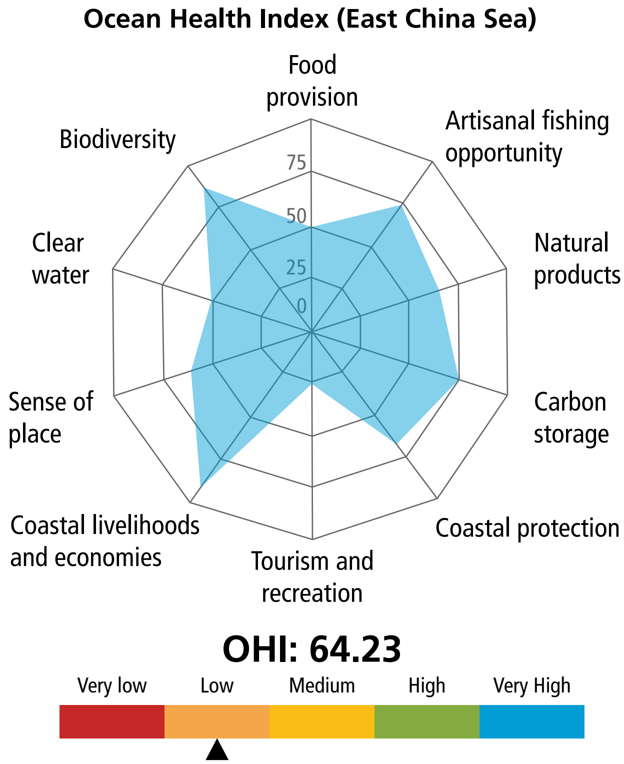
[277] Benjamin S. Halpern, Melanie Frazier, Benjamin D. Best, Catherine Longo, and J.S. Stewart Lowndes in UNESCO-IOC/GEF/UNEP TWAP, 2015f.

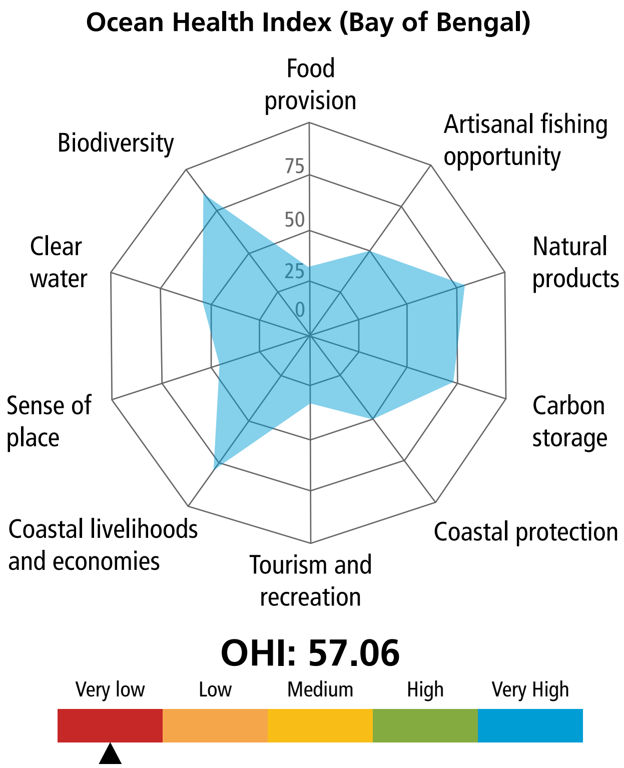
[278] Agardy *et al.*, 2005.

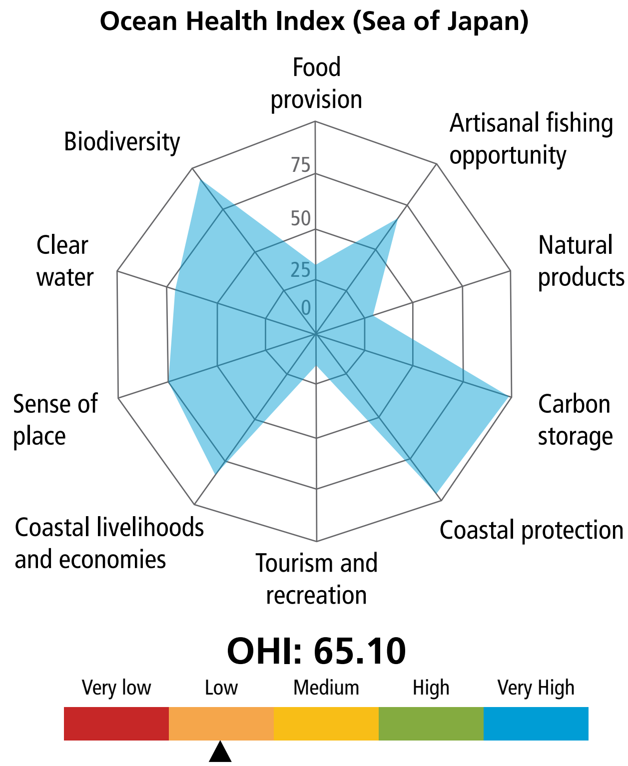

Ocean Health Index (Sulu-Celebes Sea)
Food provision
Artisanal fishing opportunity
Natural products
Carbon storage
Coastal protection
Tourism and recreation
Coastal livelihoods and economies
Sense of place
Clear water
Biodiversity
75
50
25
0
OHI: 60.13
Very low
Low
Medium
High
Very High


Ocean Health Index (Indonesian Sea)
Food provision
Artisanal fishing opportunity
Natural products
Carbon storage
Coastal protection
Tourism and recreation
Coastal livelihoods and economies
Sense of place
Clear water
Biodiversity
75
50
25
0
OHI: 61.75
Very low
Low
Medium
High
Very High


Ocean Health Index (Yellow Sea)
Food provision
Artisanal fishing opportunity
Natural products
Carbon storage
Coastal protection
Tourism and recreation
Coastal livelihoods and economies
Sense of place
Clear water
Biodiversity
75
50
25
0
OHI: 63.90
Very low
Low
Medium
High
Very High


Ocean Health Index (East China Sea)
Food provision
Artisanal fishing opportunity
Natural products
Carbon storage
Coastal protection
Tourism and recreation
Coastal livelihoods and economies
Sense of place
Clear water
Biodiversity
75
50
25
0
OHI: 64.23
Very low
Low
Medium
High
Very High





15.5 Governance Architecture in the LMEs in the EAS Region

The LME approach is in keeping with Professor E. Mann Borgese's ocean vision for the "making of a new integrated order based on new forms of international cooperation and organization"[279] She drew attention to the need to advance the legal authority for management of the oceans under the terms of the law of the sea. The integrated, ecosystem-based management, and multi-stakeholder approach in the LMEs reflects a new way of ocean governance that is very much in keeping with her philosophy wherein the common ocean interests bind countries together in peaceful pursuit of socioeconomic benefits on behalf of their people.[280]

15.5.1 Sulu-Sulawesi Seascape

The Sulu - Sulawesi Seas comprise the Sulu-Celebes Sea Large Marine Ecosystem (SCS-LME), also called the Sulu-Sulawesi Marine Ecoregion (SSME) or the Sulu-Sulawesi Seascape (SSS) under the Coral Triangle Initiative. It is an area of about 900,000 km^2 of marine resources. The SSS is located in the midst of three ASEAN nations – Indonesia, Malaysia and the Philippines. It is known for its high biodiversity (in terms of species composition and distribution, and unique species), rich fishing grounds, and extensive areas of mangroves, peat swamps, seagrass and coral reefs.

[279] E. Mann Borgese, 1986.
[280] E. Mann Borgese, 1986.

However, there are various pressures, which affect these resources and ecosystems. The major transboundary issues in the SSS are: (a) unsustainable exploitation of fish; (b) habitat loss and community modification; (c) climate change; (d) marine pollution; (e) freshwater shortage; and (f) alien and invasive species.

The Regional Strategic Action Programme (RSAP) on Fisheries Management focuses on the Ecosystem Approach to Fisheries Management (EAFM) of small pelagic stocks in the SSS, and embodies a set of regional targets, activities and indicators, and supporting national targets, under 6 themes:

- Science-based social and management interventions
- Resource valuation
- Monitoring, control and surveillance
- Information, education and communication (IEC)
- Livelihood development
- Capacity building

Examples initiatives in the Philippines are shown in **Table 15.7**.

Table 15.7: Blue Economy Initiatives of the Philippines in the Sulu-Sulawesi Seas.

	Projects, sites, and activities	SDGs being addressed
Habitat restoration and conservation; Marine debris	- SMARTSeas Philippine Project - Verde Island Passage (VIP) - VIP-wide network	SDGs: 5, 9, 13-17
Sustainable fisheries (seasonal closure)	- SMARTSeas Philippine Project - Balayan, Talin and Nasugbu Bays - Marine transponders (RADAR)	SDGs: 5, 9, 13-17
Great Green wall of Mindoro	- SMARTSeas Philippine Project - Turing, JJSea, Oriental Mindoro ~350km Modular infrastructure	SDGs: 5, 9, 13-17
Green-Grey Adaptation	- FFEM (French Global Environment Fund) - Concepcion, Iloilo - Modeling; Conservation agreements, tenurial rights system	SDGs: 5, 9, 13-17

Source: PEMSEA. 2017. Proceedings of the Regional Blue Economy Forum, 2017.

To protect the endangered sea turtles and provide safe havens, an initiative on sea turtle MPA network has been proposed at the CMS COP in October 2017. The following sites have been identified for the MPA network:

- Philippines: El Nido-Taytay, Palawan; Tubbataha; Turtle Islands; Balabac
- Indonesia: Bunaken National Park; Berau Marine Conservation Area
- Malaysia: Sipadan Islands; Tun Sakaran Marine Park; Turtle Islands Park; SIMCA and Tun Mustapha Park

In July 2018, CTI-CFF held a Sulu-Sulawesi Seascape Regional Convergence Meeting: Towards Establishing Transboundary Coordination Mechanisms for the Sulu-Sulawesi Seascape and the Review of the Sulu-Sulawesi Seas EAFM Plan. Some of the key recommendations from the meeting include:

- Facilitate the establishment of the regional or Tri-national MPA Network.
- Follow up on the Capacity Needs Assessment results, and share, present, and discuss.
- Together with partners, envision strengthened transboundary cooperation within the region towards the protection of marine turtle habitats and effective fisheries management.

The following are the new initiatives and future projects related to MPA Networks and transboundary/connectivity issues:

- CTI-CFF/UQ/GEF Project Proposal on **Seascape Approach to Securing Coral Reef Fishery and Biodiversity Resources in the Sulu-Sulawesi Seascape:** This project aims to implement a new design of MPAs, focusing on the protection of keystone reefs for coral recovery and maintenance of high habitat quality as well as creation of Fisheries Replenishment Zones (FRZs), which strengthen food security and livelihoods.
- WWF – EU and KfW **Ocean Governance**: aims to protect and restore marine ecosystems to reinforce resilience into existing habitats and become catalysts for building peace and security and fostering sustainable economies.
- **Solutions for Marine and Coastal Resilience in the Coral Triangle** (SOMACORE) – GIZ BMU: aims to support further development, adaptation, and implementation of the *Seascapes General Model, and Regional Framework for Priority Seascapes* in the respective countries in close cooperation with the CTI-CFF Seascapes Working Group.

15.5.2 Yellow Sea Large Marine Ecosystem

A total of 23 potential priority areas (PPAs) have been identified in 2007, based on the assessment of habitat of endangered birds and marine mammals, fish spawning, nursery and feeding grounds, aquatic plants, invertebrates, mollusks, etc. In 2009, China and RO Korea signed the Strategic Action Programme (SAP) committing to take actions to achieve 11 targets to restore the ecosystem carrying capacity of the Yellow Sea and its sustainable development. The YSLME SAP is being implemented through the Yellow Sea Partnership, consisting of governments at national and local levels, UN agencies and international organizations, NGOs, business associations, academia, etc. The YSLME Commission is the decision-making body of the Yellow Sea Partnership, currently consisting of China, ROK, UNDP and UNOPS. Conservation gaps covering fish spawning, nursery sites and feeding grounds are currently being reviewed with support from the YSLME Phase II Project.

Updating the TDA and the adoption of the updated SAP of the YSLME as a subsidiary document of the Memorandum of Understanding between PR China and RO Korea on the post-YSLME Project arrangement are the two ambitious targets agreed at the inception period of the YSLME Phase

II Project. These are also essential instruments in sustaining regional governance of the YSLME in the coming decade. The TDA update process started in 2017 and was completed in May 2020.

Examples of actions and good practices:

- Designation of conservation areas and strengthening of the management effectiveness of existing areas are planned in China, such as the eelgrass bed of Dongchu Island.
- Efforts are being made by PR China and RO Korea to reduce fishing efforts and total catch, supported by expanded seasonal closure and area closure. In China, from 2017 onwards, closed season has been extended to 135 days (May 1 - Sept 16). In RO Korea, a fishing effort reduction programme was implemented from 1994 to 2013, wherein fishing vessels have been reduced to 18,560 with costs of 1.6 trillion KRW (~US$ 1.5 billion).
- In PR China, releases of hatchery-reared juveniles have been carried out for a variety of species to rebuild collapsed stocks. With improvements in release strategies, there are reports of more successful initiatives and higher survival rates.
- Deploying artificial reefs is also supported by national programs to enhance fish stock.
- 42 national marine ranching demonstration sites have been established in China.
- Integrated Multitrophic Aquaculture (IMTA) sites in PR China and RO Korea. The values of food provisioning service and climate/nutrient regulating service provided by the IMTA mode are much higher than in a monoculture system.

Interventions made in the past years in implementation of the YSLME SAP have also yielded good results on several aspects. Some notable developments include:

- Improvement in capture fisheries as a result of reduction of commercial fishing fleets and setting of location and season limitations for commercial fishing on the Yellow Sea both by PR China and RO Korea.
- Successful and sustainable implementation of maricultural practices introduced by the YSLME Phase II Project (Integrated Multi-trophic Aquaculture, recirculating aquaculture systems, and detection and response systems to control diseases).
- Reduction in point sources of pollution through regulation of emitters and promotion of cleaner production.
- Reduction in shore-based marine litter through various initiatives both in PR China and RO Korea (monitoring, clean-up, buyback programs, public awareness, and regulations).
- Designation of coastal zones and restoration of critical habitats helped protect key aquatic species, migratory birds, and zones for nutrient recycling.
- Increase in number of MPAs in the Yellow Sea (52 MPAs in PR China side and 28 MPAs in RO Korea side).
- Positive trajectory in controlling invasive alien species in ballast water through use of portable detection devices, design of land- and sea-based ballast water exchange facilities, and treatment facilities.

15.5.3 Arafura – Timor Seas (ATS)

The following are the priority transboundary issues reported in the TDA of ATS:

- Unsustainable fisheries and decline and loss of living coastal and marine resources
- Modification, degradation and loss of coastal and marine habitats
- Marine- and land-based pollution (e.g. marine debris, sediments, oil spills)
- Decline and loss of biodiversity and key marine species
- Impacts of climate change, including ocean warming and ocean acidification.

Indonesia, Timor-Leste and Australia have signed the Declaration on Strategic Action Programme (SAP) for the Arafura and Timor Seas Ecosystems Action (ATSEA). In addition to the regional SAP, Indonesia and Timor-Leste have developed National Action Programmes (NAPs).

Table 15.8: Examples of Blue Economy Initiatives and Integrated Approaches under ATSEA.

	Indonesia	Timor-Leste	Papua New Guinea
Ecosystem approach to fisheries management (EAFM)	- Aru District (red snapper) - Aru District (shrimp)	- Viqueque Municipality (mackerel)	1 site: South Fly District
Fisheries Improvement Project (FIP)	- Aru District (red snapper) - Aru District (shrimp) - Merauke District (barramundi)		
Integrated Coastal management (ICM)	Rote Ndao District, NTT	- Barique Subdistrict, Manatuto	
ICM - Climate change adaptation		- Barique Subdistrict, Manatuto	
Ecosystem-based adaptation	Rote Ndao District, NTT		
Marine protected areas	- Southeast Aru MPA - Kolepon MPA	- Nino Konis Santana - South Coast MPA	
Pollution reduction	- Aru islands - Maluku - Rote Ndao	- Barique Subdistrict, Manatuto - Suai, Cova Lima	

Source: PEMSEA. 2017. Proceedings of the Regional Blue Economy Forum, 2017.

15.5.4 South China Sea and Gulf of Thailand

The South China Sea and Gulf of Thailand LME is bordered by eight countries. There are 270 million coastal people (5 percent of the world's population) in this LME. There are 122 major rivers draining 2.5 million km^2 of catchments.

Coastal communities are at risk from environmental degradation. There are two new projects supported by GEF:

- **UNEP/GEF Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand** (SCS SAP Project), US$ 15M: aims to assist countries in meeting the targets of the coastal and marine environment components of the approved Strategic Action Programme (SAP) for the South China Sea through implementation of the National Action Plans in support of the SAP, and strengthening the regional coordination for the South China Sea SAP implementation.[281] It will be executed with the support of the United Nations Office for Project Services (UNOPS) and SEAFDEC, in partnership with the ministries responsible for environment in Cambodia, China, Indonesia, Philippines, Thailand and Viet Nam.
- **System of Fisheries Refugia in the South China Sea and Gulf of Thailand.** (USD 3M): This is underway and executed by SEAFDEC.

These projects aim to:

- reduce coastal habitat degradation and loss
- improve management of critical habitats for transboundary fish stocks
- strengthen knowledge-based action planning for management
- facilitate regional and national integration and cooperation
- focus on target sites (e.g., 26 mangrove areas, 82 coral reefs, 21 seagrass meadows, 19 coastal wetlands, and 23 fishery refugia).

Aerial view of Kampong Smach, Preah Sihanouk, Cambodia *(Photo by KMI)*

[281] SCS SAP Project Inception Workshop Report (1 July 2021).

Timor-Leste *(Photo by M. Ebarvia)*

Jeju Island *(Photo by KOREA.NET, licensed under CC BY-SA 2.0)*

PART 4

STEERING THE RIGHT COURSE: OCEAN GOVERNANCE AND PARTNERSHIPS FOR THE OCEAN WE NEED

16 Policies and Legal Framework

"It is one world. And it's in our care.
For the first time in the history of humanity,
for the first time in 500 million years,
one species has the future in the palm of its hands."
David Attenborough

Given the scale and the pace of global environmental social and economic change, 'Business as Usual' is no longer an option. Crises can, however, provide the context and justification for new kinds of transformative actions and innovations, and history shows many examples of innovative responses. It is imperative to take immediate and decisive collective action to ensure that we safeguard our peoples' lives and livelihoods, enhance our resilience, and food, water and energy security, and ensure the environmental sustainability of our seas and their ecosystems.

Ocean governance is the process of optimizing for present and future generations benefits from the resources in the coastal and marine areas through a set of laws, rules, customs, and organizational and management strategies. Good governance, institutional capacity, and businesses willing to partner with policymakers, legislators, researchers and stakeholders can help achieve the SDGs, implement solution options more effectively, and transform to a sustainable and resilient blue economy. Ocean governance attempts to manage the ocean and its resources in a way that ensures its health, productivity, and resilience.

The following are the major underlying governance issues affecting the coastal and marine environment, ecosystems, and biodiversity:

- Land-use and coastal management plans that do not include the zoning and protection of mangroves, coral reefs, seagrass, mudflats, saltmarshes, and forests.
- Limited environmental inputs into the urban, infrastructure, and tourism development plans
- Few MPAs established
- Inadequate management system for MPAs and fish sanctuaries
- Lack of protection for endangered species, and culturally important species
- Lack of monitoring system to regularly assess the status of habitats, protected areas, fisheries, iconic species, water resources, and water quality of rivers and marine waters
- Inadequate facilities and capacity for solid waste, plastic waste, hazardous waste, agricultural waste, and wastewater management
- Lack of enforcement of fisheries and environmental laws
- Poverty, inequality, and lack of alternative livelihood and employment opportunities.

16.1 National Policies on Ocean and Coastal Management

The ocean environment is a host to various resources and diverse human activities sharing the same space where complex interactions between coastal and marine ecosystems take place. The purpose of establishing a national ocean policy is for the state to exercise its stewardship responsibilities, harmonize existing laws and ocean uses, promote coordination among government agencies concerned with the use of maritime space and resources, and maximize benefits from utilization of ocean resources within sustainable limits. The absence of an ocean policy framework largely explains most of the coordination problems that lead to functional overlaps and duplications among the relevant agencies. Moreover, institutional structure is a requisite element of an integrative and coordinative approach to ocean management, however, it is not the sole determinant of successful ocean governance.

Structural issues attendant to institutional arrangements for ocean governance are often a consequence of the **low priority given to ocean affairs** in the hierarchy of political and economic priorities of the government. This is usually reflected in the relegation of ocean matters as a peripheral concern attached to the functions of an agency whose primary agenda is not concerned with marine affairs.

A related issue concerns the formal structure of government organization for ocean affairs. Coordination and integration are central issues of contemporary discourses in ocean management. **Coordination** is the orderly and harmonized implementation of policies and programs by concerned institutions with the objective of minimizing conflicts among them. **Integration** refers to the process of balancing and prioritization of competing ocean uses. The integrated approach can be viewed as a practical way of operationalizing the concept of sustainable development, which aims to achieve economic development and equity objectives without compromising ecological integrity and the welfare of present and future generations.

1. Intersectoral integration: This calls for the horizontal integration

- among coastal and marine sectors,
- between coastal and marine sectors and land-based sectors

Traditionally, administrative bodies for ocean and coastal management are organized along specific ocean sectors, such as fisheries, shipping, and oil and gas development. The sectoral approach in managing ocean uses, however, has been known to be ineffective because of externalities produced by the different users. Such an approach will only be applicable where resources are unlimited and where interaction among users is nonexistent. With increasing number and level of ocean uses, impacts of land and sea uses, and the inherent limitations of the sectoral approach, an integrated management system is more appropriate to cope with the growing complexity of multiple resource use conflicts, and environmental and climate-related problems.

2. **Intergovernmental integration:** The vertical integration among different levels of government – federal/national/central, provincial and local – is necessary, with both top-down and bottom-up approaches.

3. **Spatial integration:** integration between the land and the ocean sides (H2O: highlands to oceans; R2R: ridge to reef)

Apart from sectoral management, the establishment of administrative boundaries over the marine space has also contributed to further fragmentation in planning and management of ocean uses resulting to a failure of management to address transboundary impacts of activities in the respective management jurisdictions. Unlike terrestrial ecosystems, managing the ocean poses a challenge to conventional management approach that relies on establishing administrative boundaries over transient ocean resources. This is further compounded by the multiple-use nature of the marine environment yielding many complementary and conflicting interactions that can only be effectively balanced through an integrated approach. On account of the multiple uses of the ocean space and the interactions between the watershed, coastal and sea areas, and their aggregate impact on the ocean environments and coastal and marine ecosystems, ocean management must necessarily be integrative in orientation.

4. **Science-management integration:** integration among the various disciplines is important in coastal and ocean management and ensuring evidence-based policy- and decision-making.

5. **International integration:** integration among countries, given the transboundary issues and global concerns, such as climate change, biodiversity loss, marine plastics, IUU fishing, etc.

Country examples

Indonesia

The Indonesian Ocean Policy is embodied in the Presidential Decree Number 16 of 2017 issued on 20 February 2017, which provides the guidelines for ministries and non-ministerial institutions and local governments to plan, implement, monitor, and evaluate the development in the maritime sector and implement the Global Maritime Fulcrum. The *Roadmap of the Indonesian Ocean Policy towards Global Maritime Fulcrum* has 7 pillars, with 75 policies/strategies. The seven pillars are: (1) Marine and human resources development; (2) Maritime Security, Law Enforcement and Safety at Sea; (3) Ocean Governance and Institutions; (4) Maritime Economy Development; (5) Sea space management and marine protection; (6) Maritime culture; and (7) Maritime Diplomacy. Moreover, the National Ocean Policy is based on six principles: 1) Wawasan Nusantara (Indonesian Archipelagic Vision), 2) sustainable development, 3) blue economy; 4) integrated and transparent management; 5) participation, and 6) equality and equitability.

The Global Maritime Fulcrum is the vision of Indonesia to become a sovereign, advanced, independent strong maritime nation that is able to provide positive contribution for peace and security of the region as well to the world in accordance with its national interests. Blue Economy is considered as a model for economic development that integrates land and maritime development while taking into account the carrying capacity of natural resources and environment.

The *Plan of Action 2016-2019* translates the seven pillars into policy programmes, with detailed strategies, objectives, timeframe, funding sources, and responsible institutions and stakeholders. It focuses on:

- Maritime Industry and Sea Connectivity
- Natural Resource Industry, Marine Services and Marine Environmental Management
- Maritime Boundary, Maritime Space and Maritime Diplomacy
- Maritime Defence and Security
- Maritime Culture

Japan

The *Basic Act on Ocean Policy* was enacted in 2007, and the first *Basic Plan on Ocean Policy* was adopted in 2008. The basic plan is updated/revised every five years. The third revised Plan was adopted in 2018. The following are the 12 policy measures:

- Promoting the development of marine resources and use
- Promoting the marine environment
- Promoting the development of Exclusive Economic Zone
- Securing maritime transport
- Assuring marine safety
- Promoting scientific research
- Promoting research and development related to marine science and technology
- Advancing marine industry and strengthening its international competitiveness
- Promoting integrated coastal management
- Conserving remote islands
- Promoting international partnership and cooperation
- Enhancing public understanding on oceans

In connection to ICM, the *Basic Plan of 2013* provides four priority policy goals:

- Promoting ICM by considering local characteristics, and assisting local governments
- Promoting ICM in conjunction with terrestrial management
- Promoting ICM in enclosed coastal areas
- Coordinating the use of coastal areas

In response to the *Basic Act* and *Basic Plan*, local governments have undertaken measures to promote ICM, and local coastal policies.

Philippines

The Philippines was one of the first countries to ratify the 1982 UNCLOS. The most significant impact that UNCLOS had on international ocean management is the concept that recognizes the interactions between the various ocean uses and their impacts to one another and to the marine environment. The country is a party to several Multilateral Environmental Agreements and IMO Conventions.

The **1994 National Marine Policy** (NMP) represents an initial attempt of the Philippines to move towards integrated management and sustainable development of the coastal and marine areas through participative policy and decision-making process that promote consistency and balance among competing ocean uses, and marine conservation, as envisaged in UNCLOS and later reaffirmed in UNCED Agenda 21, and recently in SDG 14.

Executive Order no. 533, s. 2006 adopted ICM as national policy for the sustainable development and management of the coastal and marine areas.

RO Korea

MOMAF enacted the **Basic Act on Ocean and Fisheries Development** (Korea Oceans Act) in 2002 to establish a comprehensive oceans policy.

Over the last half a century the sectoral and development-oriented ocean management in Korea has resulted in serious issues, such as over-exploitation of marine living resources, excess development of coastal areas, destruction of coastal habitats, degradation of water quality, etc. Therefore, an integrated ocean policy has to address these externalities and impacts more effectively. The basic principle of integrated ocean policy in Korea is to internalize the externalities through environment-friendly and sustainable development of ocean resources and space. This is well recognized in the **Basic Act on Ocean and Fisheries Development** (Korea's Oceans Act) as follows:

Article 2 (Basic ideology): *Recognizing that the sea is a rich repository of natural resources and a ground for living as well as a route of logistics, and as such it exerts considerable influences on the national economy and national living, the basic ideology of this Act is to cultivate the opulent and vivid seas to be bequeathed to the future generations, by creating the environment in which the marine industries are equipped with more knowledge, information and high value added, and by seeking after the environment-friendly and sustainable development or utilization of marine resources.*

Moreover, the principle of sustainable development of ocean resources and space is also well recognized in the *First Basic Plan for Marine and Fisheries Development* (Oceans Korea 21) as shown below:

i) **Creation of national ocean area, full of vitality:** To positively respond to the new ocean order through management of large marine areas and the expansion of marine economic areas and to build up a healthy and abundant ocean to hand over to the future generation
ii) **Creation of high value-added marine industry:** To improve the international competitiveness or traditional marine industry, such as shipping, port, and fisheries, through reshuffling into high-technologies and high-value producing industry
iii) **Sustainable development of marine resources:** To realize a commercial business of marine minerals, biology, and energy resources and to build up a system for sustainable development of marine culture and tourism resources through multi-use of ocean space.

Thailand

The **National Act on Promotion of Marine and Coastal Resources Management** of Thailand consists of 30 sections, focusing on the promotion of:

- *Integrated and sustainable management* (Sections 1-4, definition) (Sections 5-15, national or provincial committee):
    - Involves the establishment of the National Policy and Planning Committee on marine and coastal resources management. The Committee consists of the Deputy Prime Minister as chairperson, Minister of MONRE as vice-chairperson, representatives from all concerned ministries, and qualified scholars.
    - The integrated work of marine and coastal resources management was also applied to 24 coastal provinces by establishing Provincial Committees on Marine and Coastal Resources.
    - The provinces will develop their own policy and plan for the management of marine and coastal resources with participation of all stakeholders.
- *Public participation* (Section 16):
    - In section 16, it is stated that DMCR shall provide assistance and support to coastal communities to encourage the participation of the communities and the local administrations in the formulation of national and provincial policies and plans on marine and coastal resources management.
    - DMCR will also give advice to the communities and resource conservation network on the management, planning, maintenance, conservation, restoration and exploitation of marine and coastal resources.
- *Protection of marine and coastal resources* (Sections 17-23):
    - In section 17, DMCR will protect marine and coastal resources by declaring measures when it appears that any person causes severe damage to marine and coastal resources. The Director-General shall have the power to order such person to stop such an action or activity immediately. These marine and coastal resources include mangrove forest, coral reefs, seagrass, and beaches or coastal area that are being eroded by human activities.

  - The Minister of MONRE shall have the power to issue the Ministerial Regulation to the area that will be designated as marine and coastal resources conservation or protected area.
- *Regulations and enforcement* (Sections 24-30): provides direction how to enforce the regulations, and penalties for violations and failure to comply with laws and regulations.

Viet Nam

At the Fourth Conference of the 10th term Central Party Committee, the ***Resolution 09-NQ/TW on Viet Nam's Sea Strategy to 2020*** dated 2 September 2007 was approved. The guiding viewpoint of this strategy is: "we will become a strong country based on the sea, enriching from the sea on the basis of promoting all potentials from the sea, comprehensively developing marine industries with diverse and modern structure, creating a fast, sustainable and efficient development with long-term vision". The objective is that by 2020 the ocean economy will contribute about 53-55 percent of GDP and 55-60 percent of export turnover of the whole country; and help solve social issues, significantly improving the people's life in the coastal areas and on islands.

The Resolution on the **Viet Nam Sea Strategy to 2020** has inherited the views on the development of ocean economy and other sea-related fields issued earlier, but it is the first comprehensive Resolution of the Party Central Committee on the sea, opening a new chapter in thinking about the sea for the cause of nation development and defence in the first decades of the 21st century.

The Party Central Committee's ***Resolution No. 36-NQ/TW*** dated 22 October 22 2018 on Viet Nam's **Ocean Economy Sustainable Development Strategy** was issued on the basis of evaluating outstanding results and problems in the field of marine economic development over the past time. It points out 5 guiding views, targets to 2030 and vision to 2045, and 5 major directions, 3 breakthrough stages, and 7 key solutions. It can be said that the viewpoints, objectives to 2030 and Vision to 2045 of the Resolution 36/NQ-TW are all consistent with the approach to the blue economy, although this term is not explicitly used in this Resolution.

Accordingly, the **general objective to 2030** is: "Make Viet Nam a strong maritime nation; meet the basic criteria for sustainable development of the ocean economy; form a marine ecological culture; actively adapt to climate change and sea-level rise; prevent the trend of pollution and degradation of the marine environment, coastal erosion, and sea incursion; and restore and preserve important marine ecosystems. Make new, advanced scientific achievements as direct factor in promoting the sustainable development of the ocean economy".

Vision to 2045 is: "Viet Nam becomes a strong sea nation, develops sustainably, achieves prosperity, security, and safety; ocean economy contributes significantly to national economy, contributes to building the nation into a modern industrial country in accordance with the socialist orientation; participate actively and responsibly in solving international and regional issues related to the sea and ocean".

Timor-Leste

With support from PEMSEA, Timor-Leste has drafted its National Ocean Policy.

Box 16.1. Policy recommendations to foster a sustainable ocean economy

In order to boost the long-term development prospects of emerging ocean industries and their contribution to growth and employment, four recommendations were proposed by OECD. Policy-makers would need to:

1. Foster great international cooperation in maritime science and technology as a means to stimulate innovation and strength the sustainable development of the ocean economy. This would involve, for example, undertaking international comparative analyses and reviews of the role of government policy on technological innovations in marine and maritime activities.

2. Strengthen integrated ocean management. In particular, this should involve making greater use of economic analysis and economic tools in integrated ocean management, for example by establishing international platforms for the exchange of knowledge, experience and best practice, and by stepping up efforts to evaluate the economic effectiveness of public investment in marine research and observation.

3. Improve the statistical and methodological base at national and international level for measuring the scale and performance of ocean-based industries and their contribution to the overall economy.

4. Build more national and international capacity for ocean industry foresight, including the assessment of future changes in ocean-based industries.

Source: OECD, 2016.

16.2 Multilateral Environmental Agreements

The blue economy comprises a range of economic sectors, innovations, good practices and related policies that together determine the sustainability of our oceans and coastal resources. The potential linkages between blue economy and key areas concerning sustainable economic growth, contribution to income and jobs, pollution management, ecosystem protection, and climate change and disaster resiliency have been recognized in a number of international forums and documentations in recent years.

Blue economy is in line with key multilateral environmental, fisheries, and maritime agreements, and various initiatives, such as:

- **United Nations Convention on the Law of the Sea (UNCLOS)** – A 'constitution' for the ocean.
- **'Rio+20' United Nations Conference on Sustainable Development (UNCSD) 2012:** The key themes on blue economy: ocean as natural capital; oceans as good business; oceans as integral to Pacific Small Island Developing States (SIDS); and oceans as small-scale fisheries and livelihoods.[282]
- **Transforming our world: The 2030 Agenda for Sustainable Development:** It offers a vision of a fairer, more peaceful world in which no one is left behind.
- **Convention on Biological Diversity** and the **Aichi Biodiversity Targets**
- **Our Ocean, Our Future: Call for Action** – Resolution adopted by the UN General Assembly on 6 July 2017
- **UN Decade of Ecosystem Restoration, 2021-2030**
- **UNESCO/IOC: Decade of Ocean Science for Sustainable Development (2021–2030)**
- The **Sustainable Ocean Initiative** of the Convention on Biological Diversity
- **UNDP:** oceans as development spaces where marine spatial planning (MSP) integrates conservation, sustainable use, and ocean industries
- **FAO: Blue Growth Strategy:** sustainably harnessing the potential of oceans, seas and coasts for food, income and livelihood
- **UNEP: Sustainable Blue Economy Finance Initiative**
- **Conservation International: Blue Carbon Initiative**
- **APEC (2014): Xiamen Declaration** of the Fourth APEC Ocean-related Ministerial Meeting towards a New Partnership through Ocean Cooperation in the Asia Pacific Region: fostering economic growth through conservation and sustainable development and management.

Multilateral environmental agreements (MEAs) assist with addressing specific environmental issues at national, regional and global levels that require multilateral action in order to be effective. MEAs set out the rules describing what each country is expected to do.

Table 16.1 shows the status of adoption and ratification of related international conventions or multilateral environmental and fisheries agreements by the countries in the EAS Region.

[282] Silver *et al*., 2015.

Table 16.1: International Conventions and Agreements (Status as of 2020).

	Multilateral Agreements	KH	CN	ID	JP	KR	LA	MY	PH	SG	TH	TL	VN
Ocean													
Maritime Safety	UN Convention for the Law of the Sea 1982 (UNCLOS)	S	R	R	R	R	R	R	R	R	R	A	R, A
	International Maritime Organization (IMO Convention 1948)	R	R	R	R	R		R	R	R	R	R	R
	Convention for the Safety of Life at Sea (SOLAS) 1974	R	R	R	R	R		R	R	R	R		R
	• SOLAS Protocol 78	R	R	R	R	R		R	R	R			R
	• SOLAS Protocol 88	R	R	R	R	R		R	R	R			R
	• SOLAS Agreement 96												
	Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972	R	R	R	R	R		R	R	R	R		R
International/Transboundary Watercourses													
	Convention on the Law of the Non-navigational Uses of International Watercourses 1997 (Watercourses Convention)												A
Nature Conservation													
Land degradation	UN Convention to Combat Desertification (UNCCD)	R	R	R	Ac	R	Ac	R	R	A	A	A	A
Habitat and biodiversity	Convention on Biological Diversity (CBD), 1992	A	R	R	Ac	R	A	R	R	R	R	A	R
	• Cartagena Protocol on Biosafety 2000	A	Ap	R	A	R	A	R	R		A		A
	• Nagoya Protocol on Access and Benefit-Sharing 2010	R	A	R	Ac	R	A	A	A		Signed		A
	• Nagoya – Kuala Lumpur Supplementary Protocol 2010	A			Ac						Signed		A
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	R	Ac	A	Ac	A	A	A	R	A	R		A
	Convention on the Conservation of Migratory Species of Wild Animals (CMS) or Bonn Convention		NP	NP				NP	R		NP		NP

Table 16.1: International Conventions and Agreements (Status as of 2020). (cont.)

	Multilateral Agreements	KH	CN	ID	JP	KR	LA	MY	PH	SG	TH	TL	VN
	Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (Ramsar)	A	Notification	A	A	Ac	A	R	A		Definitive signature		A
Pollution and waste management													
Marine pollution	UNCLOS (Part XII: Protection and Preservation of the Marine Environment)	S	R	R	R	R	R	R	R	R	R	A	R
	London Convention - Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter		R		R	R			R				-
	• London Protocol		R		R	R			R				-
	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997 (MARPOL)												
	• MARPOL 73/78 (Annex I/II)	R	R	R	R	R		R	R	R	R		R
	• MARPOL 73/78 (Annex III)	R	R	R	R	R		R	R	R			R
	• MARPOL 73/78 (Annex IV)	R	R	R	R	R		R	R	R			R
	• MARPOL 73/78 (AnnexV)	R	R	R	R	R		R	R	R			R
	• MARPOL Protocol 97 (Annex VI)		R	R	R	R		R	R	R			R
	International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969	R	d	R	d	d		d		d			
	• CLC Protocol 1976	R	d		R	R				R			
	• CLC Protocol 1992	R	R	R	R	R		R	R	R	R		R
	International Convention on Civil Liability for Bunker Oil Pollution Damage (Bunkers Convention), 2001		R	R		R		R		R			R

Table 16.1: International Conventions and Agreements (Status as of 2020). (cont.)

	Multilateral Agreements	KH	CN	ID	JP	KR	LA	MY	PH	SG	TH	TL	VN
	International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990		R		R	R		R		R			
	International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001		R	R	R	R		R	R	R			R
	International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004		R	R	R	R		R	R	R			
Hazardous waste and pollution	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	A	R	A	A	A	A	A	R	A	R		A
	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade 1998	A	R	R	Ac	R	A	A	R	A	A		A
	Stockholm Convention on Persistent Organic Pollutants 2001	R	R	R	A	R	R	S	R	R	R		R
	Minimata Convention on Mercury 2013	S	R	R	Ac	R	A	S	R	R	A		Ap
Air pollution	Vienna Convention for the Protection of the Ozone Layer 1985	A	A	A	A	A	A	A	A	A	A	A	A
	• Montreal Protocol on Substances that Deplete the Ozone Layer 1987	A	A	R	Ac		A	A	R	A	R	A	A
Fisheries management													
	Convention on Fishing and Conservation of the Living Resources of the High Seas 1958	A		S				A			R		
	UN Agreement on Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995	A	signed	R	signed	R			R		A		A

	Multilateral Agreements	KH	CN	ID	JP	KR	LA	MY	PH	SG	TH	TL	VN
	Agreement relating to the implementation of Part XI of UNCLOS		√	√	√	√	√	√	√	√	√	√	√
	UN International Convention for the Regulation of Whaling, 1946				Ad	Ad			w				-
	• Protocol to the Int'l Convention for the Regulation of Whaling, 1956				R	Ad							
	Agreement to Promote Compliance with International Conservation and Management				Ac	Ac			Ac				-
	Measures by Fishing Vessels on the High Seas (FAO - Compliance Agreement, 1993)												
	FAO Agreement on Port State Measures to Prevent, Deter, and Eliminate Illegal, Unreported, and Unregulated Fishing, 2009	P		R	A	A			A		A		A
	Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean			R					R				A
	FAO Code of Conduct for Responsible Fisheries, 1995 (voluntary)												Ac
Climate change and disaster risk reduction													
Climate change	United Nations Framework Convention on Climate Change 1992 (UNFCCC)	A	R	R	Ac	R	A	R	R	R	R	A	R
	• Kyoto Protocol to the UNFCCC 1997	A	Ap	R	Ac	R	Ac	R	R	Ac	R	Ac	R
	• Paris Agreement 2015	R	R	R	Ac	R	R	R	R	R	R	R	Ap

	Multilateral Agreements	KH	CN	ID	JP	KR	LA	MY	PH	SG	TH	TL	VN
Natural hazards	Sendai Framework for Disaster Risk Reduction 2015-2030												Ap
Heritage conservation													
	World Heritage Convention (WHC)	Ac	R	Ac	Ac	Ac	R	R	R	R	Ac	R	Ac

Note: R – Ratification; A – Accession; Ac – Acceptance; Ad - Adherence; Ap – Approval; S – Succession; NP – Participating Non-Parties; d – Denunciation; w - withdrawn
√ - Ratifications of, accessions and successions to UNCLOS and related Agreements
Countries:
KH - Cambodia
CN - China
ID - Indonesia
JP - Japan
KR - RO Korea
LA - Lao PDR
MY - Malaysia
PH - Philippines
SG - Singapore
TH - Thailand
TL - Timor-Leste
VN - Viet Nam

Sources: United Nations Treaty Collection: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-a&chapter=27&clang=_en
IMO: https://www.imo.org/en/About/Conventions/Pages/StatusOfConventions.aspx
FAO: http://www.fao.org/iuu-fishing/international-framework/en/
https://www.informea.org/en/countries/
https://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm

Wildbirds in Las Piñas–Parañaque Critical Habitat and Ecotourism Area. *(Photo from DENR, Philippines)*

Shark. *(Photo from Thailand Environment Institute)*

17 Institutional Arrangements and Stakeholder Participation

"In times of crisis, the wise build bridges while the foolish build barriers."
T'Challa, *Black Panther*

Douglass North in his book *Institutions, Institutional Change, and Economic Performance* (1990: 3) defines institutions as 'rules of the game in a society', and the constraints, which shape human interaction and the way that societies evolve through time. Institutional arrangements are the policies, systems, and processes that organizations use to legislate, plan, and manage their activities efficiently, and to effectively coordinate with others in order to fulfill their mandate (UNDP). These arrangements include the linkages between and among agencies and organizations at the local, state/provincial, and national levels, and between governmental and non-governmental entities, including local community and business leaders.

The Ocean may be interconnected, but its management is deeply fragmented. To realize sustainable marine-based economic development, all parties and stakeholders are required to play their respective roles in several priorities in coordination and partnership with each other. The following were pointed out by the Brundtland Commission in the document "Our Common Future":[283]

a. Establish national regulations and regulations and their institutions as the primary basis for institutional change in sustainability building.
b. Building regional and interregional actions within a framework of mutual responsibility, accountability, and transparency.
c. Development of global institutions in institutional capacity development programs.

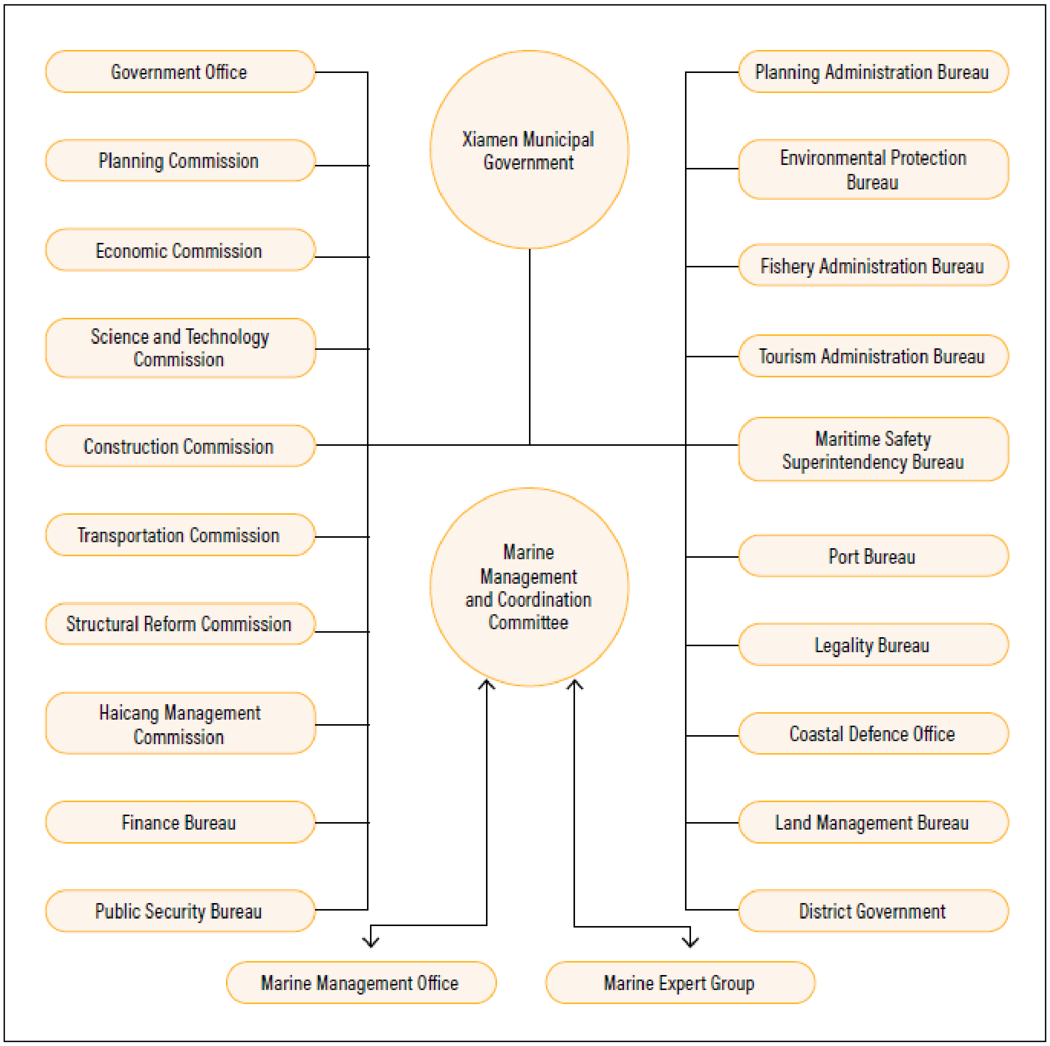
17.1 ICM Program

ICM has been defined as "a dynamic process in which a coordinated strategy is developed and implemented for the allocation of environmental, socio-cultural and institutional resources to achieve the conservation and sustainable multiple use of the coastal zone" (Sorensen, 1993). The ICM approach and blue economy development are in line with the SDGs and other international agreements on management of oceans, environment, water resources, biodiversity, and fisheries, and on climate change mitigation and adaptation.

[283] United Nations. "Our Common Future" Chapter 12: Towards Common Action: Proposal for Institutional and Legal Change. A/42/427 Annex.

The coordinated strategic planning is at the core of ICM. Engaging the different stakeholders in ICM planning and implementation of action plans and projects is crucial. One of the basic requirements of the ICM program is the establishment of an inter-agency and intersectoral coordinating mechanism. **Figure 17.1** shows the example of the organizational structure of the ICM program in Xiamen, China.

Figure 17.1: Coordinating and Organizational Structure of ICM in Xiamen, China.



Source: Xue et al. 2004.

ICM is a dynamic process, and suggests adaptive management as needs, environmental and socioeconomic issues and priorities may change over time. This requires regular monitoring and evaluation of the ICM plan, and assessment of the effectiveness of management interventions and actions, and their outcomes and impacts on the coastal environment and communities. Continuous capacity development and knowledge sharing are also essential to improve planning, decision-making, and implementation of policies and plans, including replication and scaling up of best practices and innovative measures.

Good governance together with committed leadership are crucial to realize the aims of ICM and the goal of achieving sustainable and inclusive development in the coastal areas.

Progress has been made in initiating and implementing ICM in the EAS region. The local *State of Coasts Reports* of ICM sites, together with the NSOC reports, discussed the progress and gaps in ICM implementation, and share the experiences of EAS countries in implementing the SDS-SEA thorough the ICM program as a key approach toward achieving a sustainable blue economy. Benefits and outcomes of programs and projects implemented under ICM can be quantified (as shown in the Xiamen case study)[284] to show how economic prosperity can be achieved while protecting ocean health at the same time. The ICM outputs and outcomes can also be linked to the SDGs and blue economy development. Such demonstration of actions on the ground, and sharing of the outcomes, benefits, and lessons learned from ICM implementation will facilitate advocacy for blue economy. It will also encourage countries to increase ICM sites and improve coastal and ocean management efforts.

17.2 Coordinating Mechanisms for Ocean Management

The most significant impact that UNCLOS had on international ocean management is the concept that recognizes the interactions between the various ocean uses and their impacts to one another and to the marine environment.

As a result, the **Whole-of-Government** approach becomes especially important in the context of putting institutions to the service of environmentally sound, inclusive and people-centered sustainable development. The purpose of the whole-of-government approach is to create a culture that facilitates a shared vision across diverse ministries, public administrations and public agencies in order to provide a common solution to the growing complexity of problems that call for collaborative responses. Inter- and intra-agency coordination and cooperation strengthens the abilities of various government agencies to operate as one system rather than as a collection of silos and separate components. It establishes a unified effort between government agencies to maximize all available resources—personnel, funding, and equipment and supplies—in a collaborative effort.

In addition, the government cannot do it alone, even if it can muster enough human and financial resources. The '**Whole-of-Society**' or '**Whole-of-Nation**' is advocated wherein government agencies engage all relevant stakeholders including, but not limited to, intergovernmental organizations, the private sector, civil society, communities, families and individuals in support of joint efforts to address particular problems or issues. While the whole-of-government was state-driven, the whole-of-nation approach is participatory and more of a partnership between the government and different segments of society. Integrated policy approaches, enabled by cohesive institutional arrangements, integrated governance mechanisms, stakeholder engagement, and modern technologies, contribute to the overall objectives of long-term development and ocean management.

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[284] PEMSEA, 2005.

Countries in the EAS Region have varying governance structures for ocean management as shown in the examples below. How to forge collaboration between government and society against the existential threat brought about by environmental and climate changes and biodiversity loss has become a conundrum.

Indonesia

The **National Ocean Council** was established in 2007 to coordinate ocean-related affairs. In addition, **Sea Partnerships** was also established by the *2007 Law Concerning the Management of Coastal Zones and Small Islands*. However, state institutions with an interest in the sea still make policy in a sectoral way. These institutional mechanisms should be strengthened, capable of synergizing and integrating marine development policies, crafting cross-sector solutions, and implementing actions.

Presidential Regulation Number 10 of 2015 established the **Coordinating Ministry for Maritime Affairs**. The coordinated ministries are: Maritime Affairs and Fisheries, Tourism, Transportation, and Energy and Mineral Resources. In 2019, there were changes made to some ministries The coordinating ministry is currently called the **Coordinating Ministry for Maritime and Investment Affairs**.

As stipulated in the *Presidential Regulation No. 10 of 2015*, the main duties and responsibilities of this coordinating ministry are:

- Coordination and synchronization of formulation, establishment, and implementation of ministries' policies and plans related to maritime affairs
- Control policy implementation of the Ministries/Institutions related to maritime affairs
- Coordination of the implementation of the tasks, and provision of administrative support to all elements of the organisation within the Coordinating Ministry for Maritime and Investment Affairs
- Coordination and synchronization of maritime state resilience development and marine resources management
- Coordination of maritime infrastructure development policies
- Management of the state wealth under the responsibility of the Coordinating Ministry for Maritime and Investment Affairs
- Supervises delivery of duties of the Coordinating Ministry for Maritime and Investment Affairs
- Implementation of other functions and special tasks given by the President

Philippines

The series of Presidential Executive Orders show the evolution of institutional arrangements for integrated ocean management in the Philippines:

- **Executive Order (EO) No. 186, s. 1994:** expanded the coverage of the Cabinet Committee on Maritime and Ocean Affairs (CABCOM-MOA)

- **EO No. 132, s. 1999:** "Strengthening the CABCOM-MOA and its supporting mechanisms, and establishing its Technical Committee, and for other purposes" (Chair-DFA)
- **EO NO. 612, s. 2007:** Reorganizing the DFA-Maritime and Ocean Affairs Center into the Commission on Maritime and Ocean Affairs under the Office Of The President
- **EO No. 57, s.2011:** Establishing the National Coast Watch System (NCWS)

The **Cabinet Committee on Maritime and Ocean Affairs** (CABCOM-MOA) was tasked to implement the National Marine Policy. CABCOM-MOA performed policymaking and coordination, demonstrating government efforts towards integrated and coordinated ocean governance. The CABCOM-MOA, during its operational years, have increasingly gained legitimacy among the agencies as the highest authority in shaping the direction of Philippine ocean policy.

CABCOM-MOA was abolished in 2001, and subsequently, an office was set up in the Department of Foreign Affairs (DFA) to handle marine affairs. There was a realization that ocean management is not just about foreign affairs and national security. Hence, in 2007, the inter-agency Commission on Maritime and Ocean Affairs was established under the Office of the President.

In 2011, the **National Coast Watch System** (NCWS) was established. The National Coast Watch Council, with its Secretariat, performs as the central inter-agency mechanism for a coordinated and coherent approach on maritime issues and maritime security operations to enhance governance of the Philippines' maritime and ocean interest, and "To be a Global Leading Maritime Nation."[285]

There was a notably slow progress in the implementation of the ocean-related programs attributed to the lack of link between the national ocean planning process with the overall national development planning. The experience of both the CABCOM-MOA, Commission on Maritime and Ocean Affairs, and NCWS clearly show that ocean policies and programs must be well-integrated into the national planning and programming priorities and spelled out in the Medium-Term Philippine Development Plan, and supported by budget allocation. The lack of integration of the national ocean planning process with the overall national development planning needs to be addressed. Ocean policies and programs often have concomitant public investment requirements, which if not included in the national planning and programming priorities would likely fail due to inadequate resource complement.

RO Korea

The **Ministry of Oceans and Fisheries (MOF)** is a cabinet-level ministry with the overall responsibility for maritime affairs and fisheries management, ranging from the promotion of maritime safety and security, protection of the marine environment, development of port and fishing ports, research and development on polar issues to the management and sustainable use

[285] NCWS's Mission and Vision (https://ncws.gov.ph/)

of fishery resources, and the promotion of marine leisure activities. The MOF was established as part of a general cabinet reorganization in 2013.

Before 1996, maritime functions had been divided among various departments. From 1955 to 1961, a Ministry of Marine Affairs existed, but there are other ministries responsible for fisheries, maritime shipping and ports. In 1996, however, the Korean government integrated the fragmented government authorities into one single agency, the Ministry of Maritime Affairs and Fisheries (MOMAF).

In 2008, the Ministry of Construction and Transportation and MOMAF were merged, and the Ministry of Land, Transport and Maritime Affairs was established. In 2013, the MOF was established. It is currently tasked to implement the following national policies:

- Protecting marine territorial integrity and strengthening maritime safety
- Building a global maritime power hub by win-win partnership between shipping and shipbuilding
- Maintaining clean seas and bountiful fishery

China

Reforms announced at the 2013 annual meeting of the National People's Congress led to the consolidation of four of China's five maritime law enforcement commands into the Chinese Coast Guard and to the formation of a high-level body called the National Ocean Committee, which is tasked with coordinating leadership and strategy on ocean affairs. These two new entities were housed at the State Oceanic Administration (SOA), which itself received an extensive organizational overhaul on June 9, 2013, to improve its ocean-related jurisdictional authority— excluding marine fisheries management.

In March 2018, China announced a "*State Council Institutional Reform Plan*" that ordered extensive restructuring of the central government, across nearly the full range of existing ministries. One provision of the reform plan essentially dissolved the existing SOA, moving many of its responsibilities to the new **Ministry of Natural Resources** and distributing others to new ministries and agencies— including the Ministry of Ecology and Environment, Central Foreign Affairs Work Committee, and People's Armed Police. The reform plan also transferred oversight of marine fishing vessels from the Ministry of Agriculture to the Ministry of Transportation.

Thailand

Similar to many countries in the EAS region except Indonesia and RO Korea, Thailand has no single ministry responsible for the whole range of marine affairs. The responsibilities related to the marine sectors are shared by many ministries, such as the Ministry of Agriculture and Cooperatives, Ministry of Transport, Ministry of Energy, and Ministry of Natural Resources and Environment.

18 Sustainable Financing, Investments, and Incentives

"There is no such thing as a free lunch."

Economic activity in the ocean is increasing and quite substantial as shown by the value of the ocean economy globally and in the EAS region. It is essential that the ocean economy does not compromise ocean health on which it relies on. Protecting the ocean and rethinking of the ocean economy are crucial for the long-term habitability of the planet. Many activities and investments, past and planned, are not environmentally sustainable.

Making SDG 14, "life below water" a reality will require an estimated US$ 174 billion annually. Of this amount, the greatest resources, USD$ 87 billion, must be devoted to combating marine pollution, followed by US$ 40 billion for ecosystems protection (through conservation or management), and US$ 28 billion for fisheries.[286] There is a clear funding gap. Note that this is just one of the SDGs.

More sustainable financing and investments are now needed to reverse the impacts from the degradation of ecosystems and changing environment and climate. Financing is key, and policy action is required to create the conditions needed to reorient investment and financing towards more sustainable activities, especially in the ocean and coastal areas..

18.1 Financing Blue Economy and Ocean Health

What is ocean financing?

Sustainable ocean financing refers to the expenditure that contributes – or intends to contribute – to the transformation towards blue economy and sustainable use of the ocean, including restoration and conservation of coastal habitats and biodiversity, climate action, pollution reduction, circular economy, and improvement of marine water quality.

UNEP defines finance for the sustainable blue economy as "financial activity (including investment, insurance, banking and supporting intermediary activities) in, or in support of, the development of a sustainable blue economy, for example through the application of the **Sustainable Blue**

[286] UNESCAP, 2020.

Economy Finance Principles in financial decision-making, **Environmental, Social, and Governance** (ESG) frameworks, and reporting." As such, it covers both finance being deployed directly to invest in blue economy projects (e.g., into specific projects) as well as financial activity/ capital being deployed to support the development of the blue economy more broadly (e.g., activity by financial institutions to de-risk, promote or further mainstream investment into the sustainable blue economy).[287]

Ocean finance is essential to transition to a blue economy by defining standards and metrics, developing a pipeline of bankable ocean investments, innovating finance instruments, mobilizing capital, aligning taxes and subsidies, and strengthening policy, knowledge, and capacity.[288]

The goal of ocean finance is to generate, invest, align, and account for financial capital and other funding mechanisms to achieve sustained ocean governance and improved ocean health (Walsh 2018). An ocean governance financing strategy covers the following:

a. budget allocation for ocean management plan and action plans (e.g., institutional capacity development, pollution management, habitat restoration and MPAs, fisheries management, blue carbon, climate adaptation, etc.)
b. revenue-generating streams (tax and non-tax instruments), with earmarking for ocean-related action plans
c. accessing financing and investment from a variety of sources, modalities, and mechanisms
d. aligning regulations, standards, and public and private incentives to enhance ocean health and support sustainable ocean economic activities.

What are the available financing sources and mechanisms?

Ocean finance comes from both public and private sources, can be mobilised through various domestic and international finance instruments, and may be channelled through various intermediaries. **Figure 18.1** illustrates these financing mechanisms in biodiversity conservation, which are also used in climate finance and low carbon investment. Scaling up sustainable ocean finance needs to be coupled with a reallocation of resources away from harmful activities. In addition, the returns from the trillion-dollar ocean economy can be used to contribute to the financing of ocean health improvement.

Usually, government budgets are inadequate to fund the effective ocean management and governance, while market and policy failures, such as open-access regime (e.g., fisheries), and lack of bankable projects, hinder private-sector investment in the blue economy. Nevertheless,

[287] UNEP, 2020.
[288] ADB, 2021.

there are revenue-generating streams and an array of financing modalities and mechanisms that can be explored to support ocean governance, such as:

a. **Public domestic finance flows.**
   - General budget allocation
   - Carbon taxes
   - Ocean-related fees and charges (e.g., environmental user fees, fish licensing fees, tourism fees, diving fees, entrance fees to marine national parks, charges on sewage discharge into the ocean and fines for non-compliance

b. **Public finance international flows.** Public international finance refers to financial transfers from a government, public agency, or public financial institution to support the ocean governance objectives in another country. It includes Official Development Assistance (ODA), Official Development Finance (ODF), other official flows (OOF), and other bilateral and multilateral flows.
   - *Foreign direct investments* (in the ocean economic sectors and environmental investments)
   - *Foreign capital, aid, assistance, and loans*
     - Official Development Assistance by bilateral development partners (US$ 20 million annually) and partners (US$ 10 million annually).
     - Green Climate Fund: offers support to enable developing countries to implement marine and coastal ecosystem-based adaptation and mitigation efforts, with a focus on biodiversity conservation and protected area management
     - Biodiversity Finance Initiative
     - ocean funds of international financing institutions (IFIs) like the World Bank and ADB
   - *International financing institutions*
     - ADB: Oceans Financing Initiative (OFI) and Healthy Ocean Action Plan; ASEAN Green Catalytic Finance Facility (pilot of OFI).
     - World Bank: PROBLUE multi-donor trust fund
     - European Investment Bank (EIB): Blue Sustainable Ocean Strategy
     - ADB and EIB: Clean and Sustainable Ocean Partnership
   - *Debt instruments*
     - blue bonds
     - climate bonds
     - National debt restructuring: Debt-for-Nature swaps

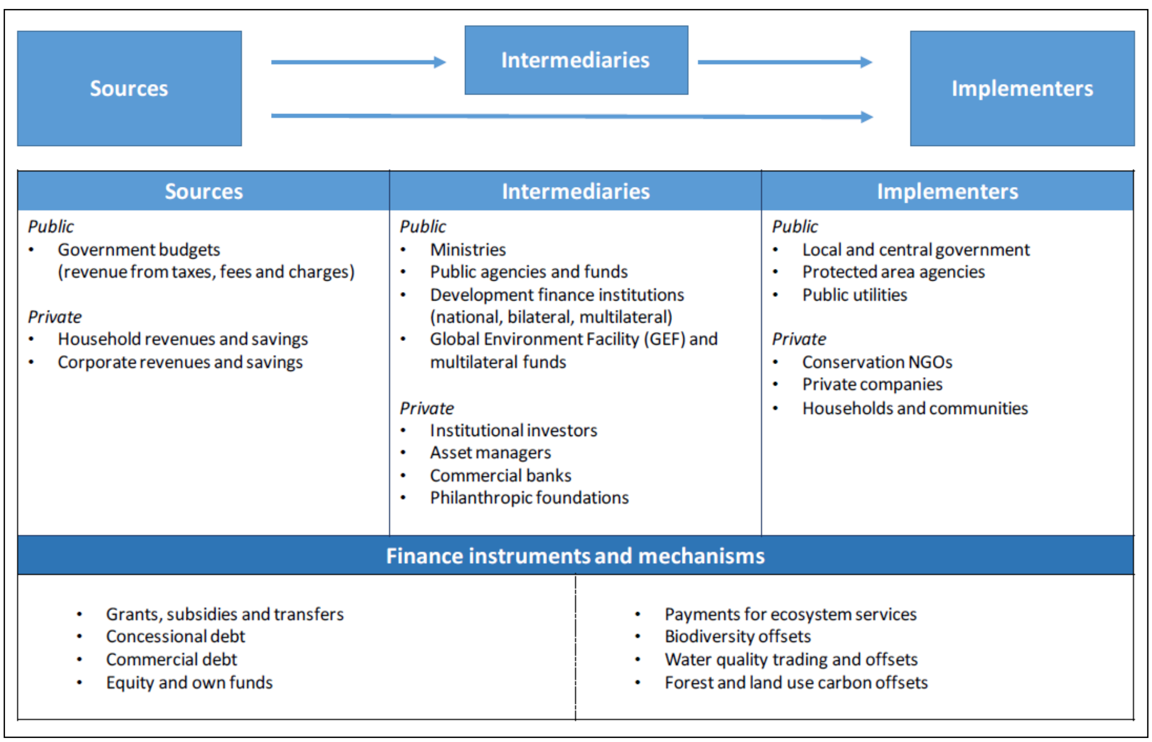
c. **Private flows.** There is a range of instruments available and opportunities for scaling up ocean financing and investments from the private sector:
   - *Insurance mechanisms*: nature-based climate and disaster insurance, parametric or index-based insurance, shipping insurance, agricultural insurance, etc.
   - *Philanthropies/foundations, impact investments and dedicated ocean funds:* Bloomberg Philanthropies Vibrant Oceans Initiative, Mirova's Althelia Sustainable Ocean Fund (SOF), etc.

- *Blended finance:* strategic use of development finance and philanthropic funds to mobilize private capital flows (e.g., Ocean Risk and Resilience Action Alliance or ORRAA); private finance leveraged by the Global Environment Facility (GEF)
- *Public-private partnerships*: biodiversity enterprises, environmental investments (PPP for solid waste management, wastewater treatment facilities), Marine Conservation Agreements (for biodiversity and fisheries management and sustainable tourism, such as in Fiji), corporate social responsibility (CSR) projects, etc.
- *International biodiversity conservation NGOs*: The Nature Conservancy, WWF, Conservation International and affiliates, etc.

Meanwhile, there are other non-tax instruments and opportunities for financing ocean-related plans and programs, such as:

- payment for ecosystem services (PES)
- blue carbon markets and REDD+; carbon trading and offsets; forest and land-use carbon market
- biodiversity offsets
- tradeable permits; tradeable fish quotas
- environmental guarantee funds
- deposit-refund schemes
- levy on single-use plastic bags and bottles
- conservation trust fund
- sustainable commodities: certification; labeling (e.g., Marine Stewardship Council)

Figure 18.1: The Biodiversity Finance Landscape.



Source: OECD. 2020. A Comprehensive Overview of Global Biodiversity Finance. Adapted from Hainaut et al., 2018, Landscape of climate finance in France, low-carbon investment 2011-2017, IC4E – Institute for Climate Economics.

Box 18.1. OECD: The case for sustainable ocean finance

Key messages:

1. **Create a race to the top for sustainable ocean finance**. As is the case with ***net-zero emissions targets*** to tackle climate change, it is important for countries and organisations to aim for ambitious objectives on sustainable ocean finance and push each other to do better. While more investment is needed for the ocean, it is also true that the majority of ocean finance is currently unsustainable and potentially harmful to the environment. Scaling up sustainable ocean finance needs to be coupled with a reallocation of resources away from harmful activities.
2. **Set conditions for longer-term investment**. Governments need to find the right mix of policies, regulations, and incentives to boost sustainable ocean finance. This includes better ocean management and science-based planning for the use of marine resources and coastal ecosystems. It also means using public capital to de-risk sustainable ocean finance products, for example through different forms of blended finance. To bridge the gap between financial flows and projects, authorities have to find better ways to match ocean-seeking capital to available projects.
3. **Empower local authorities**. Municipalities and local communities have an important role to play in ensuring protection and sustainable use of the ocean. However, they often lack the ability to raise finance to shape and implement sustainable ocean-related projects. Some municipalities still do not have the power to borrow but ***multilateral development banks*** and ***philanthropic organisations*** are keen to find ways to unblock investment in blue projects at the local level. The lack of technical expertise can be an issue at the local level but can be resolved to a large extent with investments in knowledge-sharing and capacity-building.
4. **Exploit the relevant lessons from green finance**. There are still some conflicting views on how to best frame finance in the ocean economy, but there is consensus over the need to learn from the experience of green finance. To give just one example of many, the emerging enthusiasm for ***ocean-focused "blue bonds"*** can draw on the rapid development of the ***green bonds framework*** and standards in recent years. There might not even be a need for blue bonds per se but rather "bluer" green bonds, complementing the idea that the ocean has to be an integral part of post-pandemic green recovery packages.
5. **Push for a greater role for the ocean in nature-based solutions**. Mainstreaming effective marine and coastal ***nature-based solutions (NbS)*** is a key opportunity to mitigate climate change, reduce ocean biodiversity impacts, build resilience of coastal communities, and help unlock ocean finance. It is vital to recognise NbS for climate, but scalable financing mechanisms are needed. Coastal ecosystems and communities must be an integral part of that process. The benefits of ***unlocking investment in coastal resilience*** also have to be considered.

Source: Prag and Moorghen. 2020.

18.2 Investments for Blue Economy and Ocean Management

The Economist[289] defined the blue economy investments as:

- Those where investments account for environmental, social and governance (ESG) risks in the planning and execution of activities in the ocean, and where ESG management is both good for business and good for the environment.
- Those where there is a strong business case for investing in the ocean, and where a side benefit of the investment is improving the health of the ocean.
- Those where investments are explicitly focused on ocean health and ecosystems.

Investment in sustainable development of oceans is often perceived as untested and risky, particularly in a region like East Asia. Investors may have concerns about ease of doing business, rule of law, local management and enforcement capacity, available infrastructure, clear zoning rules and property rights, all of which can have severe consequences for an investment.[290]

18.2.1 Developing Bankable Investment Projects

In 2015, stakeholders from eight PEMSEA countries identified more than 300 items for potential investment across 10 governance and management categories for oceans and coasts. The investment opportunities are focused on:

- ICM Development and Implementation
- Pollution Reduction and Waste Management
- Habitat Protection, Restoration and Management
- Natural and Manmade Hazard Prevention and Management
- Water Use and Supply Management
- Enterprise and Livelihood Development
- Coastal Transport
- Energy
- Fisheries and Food Security
- Ecotourism / Sustainable Tourism

All the above ocean economic sectors and ocean management aspects have been discussed in previous sections of this report, including the current situation, pressures, and response measures covering policies, plans, actions, and initiatives to transform to sustainable blue economy. It is obvious that there are huge gaps to achieve the goal of healthy ocean, people and economies. Financing and investments are needed to support more actions, develop necessary facilities, and apply innovative technologies and practices. It is also recognized that government budget and

[289] Economist Intelligence Unit briefing paper for the Economist Events World Ocean Summit 2015.
[290] Whisnant and Ross, 2019.

donor funding are not enough, and local governments in the ICM sites are keen to get the involvement of the private sector.

PEMSEA is working to strengthen its pre-investment services to assist countries and ICM sites in the EAS region develop investible projects that are financially sustainable and at the same time, generate measurable social, economic, and environmental benefits in support of the objectives and priorities of the regional strategy, the SDS-SEA. PEMSEA, in partnership with project developers, worked on the following four pilot investment cases to improve understanding of investment services:

- **sustainable seafood:** sustainable grouper farming operation, including vertically integrated hatchery, nursery and grow-out operations aiming to produce live and fresh products for the Philippines and regional Asian markets
- **marine protection and sustainable tourism:** co-management scheme for MPA management based on public-private partnership (PPP) between local government and a newly-created private operator
- **wastewater management:** pre-feasibility investment case for wastewater and resource recovery in a special economic zone in the Philippines
- **marine plastic pollution prevention:** partnership with an investment management firm to channel financing to companies and infrastructure that prevent ocean plastic pollution

The investment cases were designed to generate risk-adjusted financial returns. The key findings from the four cases are related to: (a) good governance; (b) capacity of local governments and local entrepreneurs; (c) local knowledge; (d) value-added partnerships; (e) time and resources needed to develop bankable investments and make meaningful progress; (f) impact investors and impact metrics; (g) risk management; (h) marketing of investment opportunities. These are the essential ingredients to increase uptake and development of the major investment opportunities in blue economy.

18.2.2 Advancing Ocean Industries towards Blue Economy and Sustainable Production

The UN Global Compact (UNGC) Action Platform for Sustainable Ocean Business takes a comprehensive view at the role of the ocean in achieving the 17 SDGs (**Box 18.2**). The aim is to explore attractive and viable solutions and best practices for sustainable use and management of the ocean. By bringing together the leading industries in shipping, aquaculture, fisheries, energy production, with key equity funds, banks and insurance companies, the Platform has a cross-industry, cross-UN and cross-SDGs approach. The Action Platform is designed to drive decision-making processes and catalyze partnerships to advance shared ocean priorities across all 17 SDGs. Maintaining healthy ocean environments is a fundamental precondition for business to operate in the long-term, and addressing current challenges provides a significant business opportunity.

Box 18.2. Sustainable Ocean Business Action Platform

The Sustainable Ocean Business Action Platform of the United Nations Global Compact (UNGC) convenes leading actors from business, academia, and government institutions to determine how ocean industries can advance progress towards the SDGs, particularly goal 14 (Life Below Water). The platform will ***"focus on growth, innovation and sustainability, aiming to mobilise the private sector to take tangible action to leverage the ocean as a resource to deliver [the SDGs]."*** (UNGC)

Why Sustainable Ocean Business?

The ocean has a key role to play in transitioning to a net-zero resilient economy, and delivering on the SDGs. To meet these ambitious targets, there is a need to expand the use of the ocean to produce food and energy, and improve transportation. Sustainable management of the ocean can also reduce environmental degradation and contribute to climate change mitigation.

Businesses have a shared responsibility, alongside Government and civil society, to take necessary action to secure a healthy ocean. The **Sustainable Ocean Principles** were developed in consultation with over 300 stakeholders to provide a framework for responsible business practices across sectors and geographies. Companies signing on to the Sustainable Ocean Principles commit to integrating ocean sustainability into their business operations and overall strategy.

Accelerating ocean-based solutions

Ensuring a healthy ocean and scaling up ocean-based solutions also represents a significant opportunity for business and economic growth. The Sustainable Ocean Business Action Platform has identified the *5 Tipping Points for a Healthy and Productive Ocean*, a set of tangible objectives for the ocean to support sustainable development. The tipping points cover five critical areas for success: (a) sustainable seafood, (b) decarbonizing shipping, (c) harnessing ocean electricity, (d) mapping the ocean, and (e) ending waste entering the ocean. To provide a roadmap for Governments and businesses to jointly achieve these tipping points, the Action Platform developed the *Ocean Stewardship 2030* roadmap. This roadmap will serve as a benchmark to track progress over the coming decade.

Catalyzing investments to fund sustainable ocean business

Finance will be a key enabler to achieve the ambitions set in the *Ocean Stewardship 2030* roadmap. Innovative finance mechanisms, such as **blue bonds** show great potential for

Box 18.2. Sustainable Ocean Business Action Platform (cont.)

catalyzing the necessary large-scale investments needed to advance progress towards the SDGs.

The **Blue Bonds initiative** convenes leading actors from the financial sector, second party opinion providers, ocean industries, and multilateral development banks to accelerate blue bond issuance in the financial markets and to create a broad consensus of what constitutes "blue".

Source: United Nations Global Compact (https://www.unglobalcompact.org/take-action/action-platforms/ocean)

18.2.3 Investing in Climate Resiliency: The Private Business Sector Perspective

As emphasized by BSR (Gallagher, 2018): To reduce the risks that businesses face from climate change, and to seek opportunities in the marketplace, the private sector in Southeast Asia can build resilience across value chains by strengthening a series of components known as "capital assets"—human, political, physical, financial, social, and natural capital. Resilience does not need to be a radical change in how a business operates… Building resilience can be incremental, consisting of several steps that help avoid interruption to productivity. These steps include (1) developing a governance structure; (2) analyzing climate risk throughout operations, the supply chain, and communities in which the business works; (3) mapping assets to mitigate risk and build resilience; (4) partnering with others to streamline resources and scale resilience; and (5) disclosing and reporting on risks and progress to build resilience transparently to boost stakeholder confidence and maintain credibility. Building resilience can help a business protect its valuable assets, maintain productivity, and reduce costs. However, the benefits to building resilience extend beyond business continuity and asset protection and link to the broader community and operating context (**Box 18.3**).

18.2.4 Incentives and Rewards for Going Green and Sustainable for Blue Economy

Green Ports and Green Awards for Ships

In addition to compliance with IMO, there are financial benefits for ship owners to transform to green ships. Japanese ports, such as the Ports of Nagoya, Yokohama, and Kitakyushu, are providing incentives (discount for port dues) for Green Award Ships. Likewise, a Chinese port supplier (Kamji Marine Agency Ltd) in Ningbo-Zhoushan port is offering Green Award certificate holders discounts on a wide range of services including sludge disposal, tanker cleaning, dry dock repair, technical repair, store and spare parts supply.

Sustainably sourced seafood

Fisheries that wish to demonstrate they are well-managed and sustainable compared to the science-based standard of the Marine Stewardship Council (MSC) are assessed by a team of experts who are independent of both the fishery and the MSC. Seafood products can display the blue MSC ecolabel if that seafood can be traced back through the supply chain to a fishery that has been certified by the MSC. When buyers choose MSC-certified fish, well-managed fisheries are rewarded for sustainable practices. In turn, the growing market for certified sustainable seafood generates a powerful incentive for other fisheries to demonstrate they are fishing sustainably or to improve their performance so that they too can be eligible for MSC certification. In this way, the MSC program helps to harness market forces to incentivise positive environmental change.

Box 18.3. Why Businesses Should Invest in Climate Resilience

Business Benefits: Resilience can enhance business operations and lead to competitive advantage or new opportunities, such as:

- Stable operations, by protectiong infrastructure and production from climate impacts.
- Increase customer loyalty and consumer trust, by maintaining production and quality products and services.
- Enhanced logistics, by identifying climate-proof transportation modes, channels, technology, and equipment.
- Greater financial savings, by receiving tax credits for adaptation and accessing new capital by meeting investor expectations.
- Business growth, by designing new or improved goods and services that the new climate reality demands.
- More secure sourcing, by protecting raw materials and ingredients from climate impacts.
- A more productive workforce, by equipping employess with tools and resources to reduce climate risk at home and in the workplace and by providing climate-proof working conditions.
- License to operate, by serving as a responsible member of the community to safeguard its people and environment while boosting the economy.

Source: Gallagher 2018. BSR (https://www.bsr.org/en/our-insights/report-view/climate-change-southeast-asia-building-resilience)

19 Ocean Science and Technologies: Leading Ocean to the Frontier of Innovations and Sustainability

"The journey of a thousand miles begins with a single step."
Lao Tzu

The role of ocean science in fostering more effective ocean governance in the face of multi-faceted challenges has been recognized as shown by the declaration of the **United Nations Decade of Ocean Science for Sustainable Development (2021–2030)**.

Ocean sciences span the physics, chemistry, and biology of marine systems. The field encompasses ocean circulation, energy dissipation, marine biology, ecology, biogeochemical cycles, water mass formation and movement, ocean temperature and salinity, nutrient cycling, and marine carbon and carbonate chemistry.

Spurred by digitalization, the transformation of ocean science, research, and innovation processes is gathering momentum. Ocean science will be crucial in developing effective measures for climate-risk assessment, adaptation, and resilience-building, especially for ocean industries like fisheries, aquaculture, shipping, ports, and other coastal infrastructure as well as for shoreline protection and coastal and ocean management.

Nevertheless, there are challenges ahead in adopting new technologies. UNCTAD (2018b) pointed out the following key points:

Countries have to develop **policies** to help people navigate the transition period that lies ahead and adapt to the new world that frontier technologies are forming.

Education will become an even more indispensable lever for development. Since digital technologies are enablers and multipliers of other frontier technologies, it is essential that everyone – especially women and girls – is given a real chance to build digital capabilities. For those who may struggle to keep up with the transformation, countries will have to be innovative in providing effective social protection mechanisms.

Most crucially, there is an urgent need for a sustained effort by the international community to ensure that the multiple gaps in technological capabilities that separate developed and developing countries are closed. **Investment in hard and soft infrastructure and human capital**, complemented by a scaled up, coherent and accelerated effort to enhance innovation systems for sustainable development are necessary to spread the economic, social, and environmental benefits of frontier technologies (UNCTAD 2018b).

19.1 Fisheries and Aquaculture

Decision-makers and managers must address this urgent and overarching question – how will fisheries and aquaculture grow and the pressures on fishery resources change over time and space? This will frame the actions needed to achieve sustainable and resilient fisheries to ensure food security, incomes, and livelihoods. Answering this question requires examination into:

- the critical dimensions of pelagic species and systems, for the commercial oceanic tuna species, neritic tuna, and nearshore pelagic fish, that support many small-scale fisheries and are managed at national and local levels.
- demersal marine fish and invertebrate production, and the pollution, siltation, and land use pattern affecting water quality coupled with altered monsoonal sequences and rising sea surface temperatures that interfere with biological processes.
- aquaculture production practices, including effluents, maintenance of ponds, sourcing of fry, use of feeds and antibiotics, conversion of mangrove areas to fish farms, overstocking, intensified seaweed farming, etc.
- consumer demand and preferences, such as considerations on safety, nutrition, sustainably sourced and organically produced products, and fair trade
- governance structure influencing (a) ecosystem-based management, (b) conservation of wild species, (c) multiple-use conflict resolution, (d) sustainable aquaculture and seaweed production, (e) non-tariff measures, such as sustainability standards, traceability, eco-labelling, fair trade, and subsidies, (f) access of fisherfolk to technologies, post-harvest facilities, value-adding industries, and markets, (g) participation of women in fisheries development planning and management.

Research priorities include life history and physiology, oceanographic context, movement and migration of pelagic fish species, food webs, ecosystem dynamics, stock assessment within the milieu of rising, acidifying, and warming seas, and fisheries accounting.

At the same time, socioeconomic research is needed to tailor fisheries management strategies to local, national, and regional conditions, including integrated coastal management (ICM), marine spatial plan (MSP), regulations, penalties, incentives, and the participation of various stakeholders. Environmental and economic risk assessment, and analysis of benefits, costs, and tradeoffs are essential for planning ahead, and putting in place appropriate and adequate measures.

Scientists and managers are ideally situated to generate new fisheries-relevant data; however, investments are needed to expand the capacity for research, and applications in planning and management for more sustainable fisheries development.

Without increased capacity development, this region will be less able to respond to the complex challenges and take advantage of opportunities for economic development as the fisheries sector could be adversely affected by the impacts of collapsing fish stocks, habitat loss, pollution, and climate change. Such capacity building can be accelerated through collaboration between the countries, regional bodies (e.g., FAO, WCPFC, ASEAN, SEAFDEC), and scientific centers of excellence in fisheries, marine science, and coastal and ocean management.

19.2 Maritime Ports and Transport

As pointed out by UNCTAD (2019b), port and shipping operations can tap into the opportunities offered by digitalization, artificial intelligence (AI), the Internet of Things (IoT) and blockchain. These aim to promote efficient and secure trade, including by offering greater supply chain visibility, and the use of electronic documents, ultimately benefiting customers who rely on shipping industry services.[291] The ports and shipping industry is increasingly taking advantage of digitalization and the key players are using joint collaborative platforms, thus, changing their business and partnership models. Improvement in liner shipping connectivity at the port level can be made possible by new technologies and innovations. The next-gen ships are also moving forward with more automation, and low carbon and low sulphur fuels. These technological advances can help improve connectivity, efficiency, and productivity – key factors that influence port call selection – and going 'green' at the same time results in decreased emissions, less energy consumed, and further increased efficiency.

R&D initiatives are also focusing on decarbonization of the ports and shipping sector. Private shipping and shipbuilding companies, with support from government and foundations, are developing and testbedding the next-gen ships using alternative fuel, and even renewable energy (e.g., wind and solar), and other technologies to become more fuel-efficient.

Box 6.2 provides examples of these innovative solution options that will not only make ships be compliant to IMO Conventions, but also become more cost-efficient and productive. **Sections 6.5**, **6.6**, and **7.3** of this report describe on-going initiatives to transform the ports, shipping and shipbuilding sectors into modern, green, and efficient industry.

The ships can also play an important role in atmospheric, oceanic, and biogeochemical observations and measurements made near the ocean surface. They can assist in the monitoring, ocean observation, and data collection.

19.3 Marine Biotechnology and Marine Bioeconomy

Although marine biotechnology already has delivered products for medicine, food, bioenergy, nanomaterials, and bioremediation, less than five percent of our vast oceanic environment has been explored.[292] Up to now, over 35,000 natural products have been characterized from marine organisms, but many more are yet to be uncovered.[293] Marine biotechnology is a scientifically and economically

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[291] UNCTAD, 2019b.
[292] Long, Degnan and Rampelotto (Eds.), 2015.
[293] Rotter *et al*., 2020.

expanding enterprise that is poised to harness the enormous but uncharted functional diversity of marine life, with its novel and rich array of biodesigns and biosynthetic capabilities. Its applications are utilized in numerous tasks, such as deriving new cancer and HIV treatments from marine organisms to localized fish and seaweed farming.

Many biological scientists are involved in marine biotechnology today. These scientists work on various genome projects by isolating genes and determining their function. A marine biotechnologist may work in the biomedical field and develop new drugs from marine organisms, in bioenergy (e.g., microbial fuel cell and biofuels), bioremediation, or in marine biomaterials technology (e.g., seaweed hydrocolloids, biopolymers to address the plastic threat, and nontoxic coatings that prevent the buildup of organisms that negatively affect ships and intake pipes that are used in power plants).

Section 10.1 discusses the current developments in marine biotechnology in the EAS Region, its application in pharmaceuticals and aquaculture, and shows the potential for future growth.

There are bioremediation opportunities in the region given the scale of pollution that needs to be addressed. Bioremediation uses micro-organisms to reduce pollution through the biological degradation of pollutants into non-toxic substances. This can involve either aerobic or anaerobic micro-organisms that often use this breakdown as an energy source. Bioremediation is not a new technique. It requires fewer resources and less energy than conventional technology, does not accumulate hazardous by-products as waste, and has therefore technical and cost advantages.

Since marine biotechnology is still in its infancy, there is a need to create effective, operational, inclusive, sustainable, transnational and transdisciplinary networks with a serious and ambitious commitment for knowledge transfer, training provision, dissemination of best practices and identification of the emerging technological trends through science communication activities.[294]

19.4 Marine Renewable Energy

Another significant, untapped renewable energy source exists: the world's oceans. It is estimated that harnessing just two one-thousandths of the oceans' untapped energy could provide power equal to current worldwide demand.[295] Engineers have attempted, with varying success, to tap ocean energy as it occurs in waves, tides, marine currents, thermal gradients, and differences in salinity to reduce dependence on fossil fuels. **Section 9** of this report discusses the various ocean energy types being studied, developed and utilized in the EAS region, and the supporting policies that would accelerate the development and adoption of marine renewable energy.

[294] Rotter *et al.*, 2020.
[295] American Society of Mechanical Engineers. 2019.

19.5 Technology Development and Technology Transfer for Coastal Ecosystem Protection and Climate Action

Coastal ecosystem protection can benefit from the Poznan Strategic Program on Technology Transfer, implemented by the GEF, and the work of the UNFCCC's Technology Mechanism.

Box 19. Poznan Strategic Program for climate technology development

Through the Poznan Strategic Program (PSP), the Global Environment Facility (GEF) provides funding to climate technology development and transfer activities. The program has supported countries to undertake technology needs assessments (TNAs), develop technology pilot projects and implement hundreds of climate projects with objectives related to climate technologies.

Countries created the PSP in 2007, when the Conference of the Parties (COP) 13 requested the GEF to elaborate a strategic programme for scaling up the level of investment for technology transfer. This was undertaken with the aim of helping developing countries to address their needs for environmentally sound technologies (ESTs). In 2008, the GEF Council approved a strategic programme on technology. The programme had three windows:

- Technology needs assessments
- Piloting priority technology projects linked to TNAs
- Dissemination of GEF experience and successfully demonstrated environmentally sound technologies

COP 14 renamed this programme the Poznan Strategic Programme on technology transfer. In 2010, the GEF submitted to the COP a plan for the PSP's long-term implementation. This plan contained five elements: support for climate technology centres and a climate technology network; piloting priority technology projects to foster innovation and investments; public-private partnership for technology transfer; TNAs; and GEF as a catalytic supporting institution for technology transfer.

In 2018, the Technology Executive Committee (TEC) updated the evaluation of the PSP focusing on the climate technology and finance centers and the pilot projects supported by the GEF under the PSP. The TEC provided key messages and recommendations on the program. Among the key messages are:

(a) The PSP has significantly raised awareness on the important role that climate technology development and transfer play in supporting countries in achieving their

Box 19. Poznan Strategic Program for climate technology development (cont.)

climate mitigation and adaptation goals, including among multilateral development banks.

(b) Piloting the regional centres has generated experience and a better understanding of different modalities for originating climate technology projects; different technical assistance (TA) instruments of support; technology transfer mechanisms; financing needs; the importance of long-term engagement, ownership and capacity-building; and the need for realistic timescales for technology transfer mechanisms to become operational and self-sustaining.

(c) Facilitating access to finance is key to scaling up investment in climate technologies. Investment and therefore upscaling are contingent upon access to climate finance, including blended finance.

(d) The implementation of the regional centres and the Climate Technology Centre and Network (CTCN) have drawn attention to the need for long-term engagement with policymakers and government agencies, including nationally designated entities, in particular on policy issues, to ensure upscaling, and the need for capacity development at the national level;

(e) The time frames for testing and operationalizing new technology transfer mechanisms (and, where applicable, ensuring they are self-sustaining) need to be realistic. It takes time to establish a track record, develop business or cooperative models and fine-tune operating procedures.

(f) The PSP pilot projects are a rich source of experience and lessons learned relevant to designing and implementing climate technology projects, highlighting the need for strong government leadership, the importance of engagement and dialogue with government, the importance of enabling environments, the importance of outreach, the need for flexibility in project design, the need for access to finance, the importance of prefeasibility and market studies, and the need for intermediate metrics

(g) Experience also highlights the need to better understand which technology transfer models and mechanisms and good practices should inform project design and implementation.

(h) Intermediate metrics are needed that can capture and measure the value of knowledge created, spillovers and de-risking future investment as well as of building a climate innovation system.

Source: TEC 2019 (https://unfccc.int/ttclear/support/poznan-strategic-programme.html)

Four River Restoration and Water Resource Management Efforts in RO Korea *(Photos from Korea Environment Institute; Lee Jin Hee)*

20 Traditional Knowledge in Ocean Governance

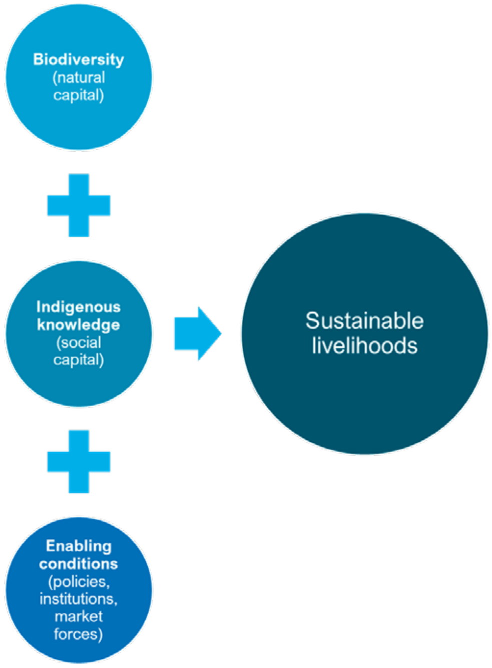
"We do not inherit the Earth from our ancestors; we borrow it from our children."
Native American Proverb

Human societies have formed relationships with the oceans through trade, travel, fishing, hunting, access and avoidance, and exploration, to name some of the drivers of why we have "set sail" through the course of history.[296]

Traditional knowledge refers to the knowledge, innovations, and practices of indigenous peoples. As pointed by the UN: "Traditional knowledge is at the core of indigenous peoples' identities, cultural heritage and livelihoods. The transmission of traditional knowledge across generations is fundamental to protecting and promoting indigenous peoples' cultures and identities and as well as the sustainability of livelihoods, resilience to human-made and natural disasters, and sustaining culturally appropriate economic development. Traditional knowledge underlines indigenous peoples' holistic approach of life, which is a central element of the world's cultural and biological diversity."[297]

Importance of traditional knowledge should not be played down as it:

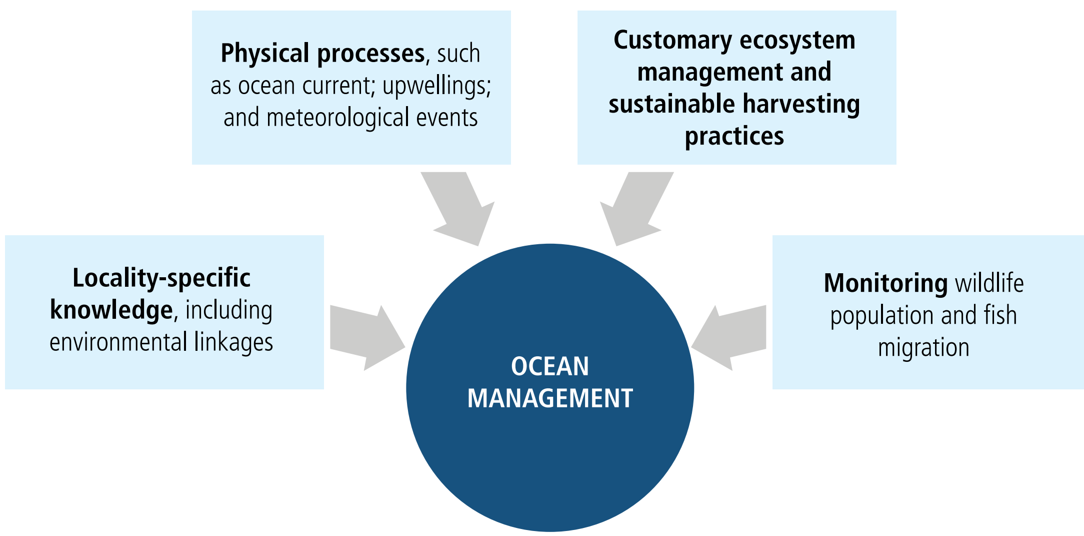
- supports food security, health, and sustainable livelihoods.
- valuable not only to those who depend on it in their daily lives, but to modern industry, agriculture, and fisheries.
- can be found in a wide variety of contexts, including scientific, technical, ecological and medicinal knowledge.
- complements science-based policy, planning, research, monitoring, and conservation programs



[296] Tero Mustonen. 2019.
[297] The United Nations Permanent Forum on Indigenous Issues: Together We Achieve. (un.org/indigenous)

Indigenous perspectives are founded upon interconnectedness, reciprocity and the utmost respect for nature. They form the basis for the traditional use and management of lands, territories, seas, and resources, with indigenous agricultural and fishing practices that care for the earth, without depleting the resources. These traditional practices have been proven to enhance biodiversity, and aids in maintaining healthy ecosystems. Protecting biodiversity through policies and plans that integrate traditional knowledge will protect and sustain livelihoods and ensure food security and resiliency. Marine resource utilization through traditional methods and local knowledge have resulted in stable fisheries stocks and marine conservation practices, a win-win for livelihood and environment.

Figure 20.1: Traditional Ecological Knowledge and Ocean Management.



Many scientific studies of local ecosystems would not have been possible without the knowledge base of indigenous people helping scientists and researchers. Traditional knowledge can be found in a wide variety of contexts, including technical, ecological and medicinal knowledge. The following vital ecological and cultural information from elders and traditional marine harvesters supports marine planning decisions:

- Important places for fishing and gathering diverse species
- ‘Seasonal rounds’ for when and where different species are harvested
- Observed changes or trends in species abundance and distribution over time
- Traditional ways of managing marine resources and areas
- Traditional fishing, gathering and food preparation methods
- Traditional medicines
- Important cultural and archaeological sites
- Travel and trade routes of indigenous people

The role of traditional knowledge is recognized in the process of the international legally binding instrument (ILBI) under UNCLOS on the **Conservation and Sustainable Use of Marine Biodiversity located in Areas Beyond National Jurisdiction** (BBNJ).

Examples

Japan's sato-umi and **sato-yama**. *Sato-yama* is rural landscape for agricultural and forestry production and livelihood comprising of communities, farmland, secondary forest, plantations, grassland, ponds, and irrigation and drainage systems. As a new concept for coastal management, *sato-umi* is based on the successes of sato-yama. *Sato-umi* concept was first proposed by Dr. Tetsuo Yanagi of Kyushu University in 1998. *Sato-umi* has been defined as:

- "a coastal sea with high productivity and biodiversity under human interaction" and is based on full understanding of the sea, such as its production systems, productivity and material cycling.[298]
- marine and coastal landscapes that have been formed and maintained by prolonged interaction between humans and ecosystems.
- marine and coastal landscape for fishery production and livelihood comprising of seashore, tidal flats, seaweed beds and grounds.

Due to the degradation of coastal ecosystem and decline of material circulation functions, which resulted in the decline of fisheries resources, restoration activities, such as establishing *sato-umi* to provide habitat for fish and shellfish, were initiated. The original focus of *sato-umi* was the Seto Inland Sea area, where communities are working together with researchers and policymakers to assess human impacts on the coastal marine environments and ecosystems. The activities that support the establishment of sato-umi include rehabilitation/restoration of seagrass beds and tidal flats, and implementation of water pollution measures with the active participation of the local public organizations. The restoration of eelgrass beds in Akou Coast was a demonstration project for the sato-umi concept.[299] Education and restoration activities were important components of the project. Strong community involvement in the project implementation made the restoration project successful.

Sato-umi has been incorporated in policies and programs on coastal and ocean management:[300]

- The *Basic Plan on Ocean Policy* (2008) points out the need to secure biodiversity in order to maintain marine resources and the aquatic environment while also highlighting the importance of the *sato-umi* concept.
- The *Strategy for an Environmental Nation in the 21st Century* (cabinet approved June 2007) clearly specifies that "implementing an integrated approach to the sustainable management

[298] Yanagi, Concept and Practices of *Sato-umi* in Japan and Lessons Learned.
[299] Matsuda, Osamu. 2012.
[300] Matsuda Osamu. 2010.

of resources through the conservation, regeneration, creation of kelp beds, tidal flats, coral reefs, as well as measures to combat water pollution in closed-sea areas, would create an abundant *sato-umi* that could support a variety of sea life, and people would be able to reap its benefits well into the future."

- Concrete action has been taken by the Ministry of Environment through the initiation of the Assistance Program for the Creation of *Sato-umi*, which was followed by the selection of Coastal Areas Under Assistance in August 2008.
- The *National Strategy for the Conservation and Sustainable Use of Biological Diversity* (2007) states the need for "the protection of coastal waters that have been designated *satoumi*". Following these objectives, the Assistance Program for the Protection of the Environment and Ecosystem was established by the Fisheries Agency in 2009.

***Sasi laut* in West Papua, Indonesia**. *Sasi laut* involves seasonal and area closures to create networks of refuges. In Kaimana District, West Papua, Indonesia, coastal communities use local knowledge to manage their marine resources. *Sasi laut* is a local wisdom and conservation practice that prohibits community members to take natural resources in a particular area over a certain period. It has therefore an important role in the preservation of the sea. Being passed down through generation, *sasi laut* combines local management system, local classification system and local belief system to manage and protect specific marine resources. *Sasi laut* usually opens around two weeks to three months and closes for one to two years. The coverage expands across Kaimana waters without the exact coordinate – the boundaries are determined by local judgment. *Sasi laut* and other conservation practices entail social-ecological complexity, in which different values are interlinked in cultural systems.[301]

***Tri Hita Karana* in Bali, Indonesia**. The Balinese Hindu community believes that man is part of the whole universal system created by God. *Tri Hita Karana* or the harmonious relationship among man, nature and God who brings welfare and happiness constitutes an important aspect of the local wisdom in Bali, Indonesia. It is applied in the field of agriculture to maintain agricultural ecosystem and sustainable farming. The same philosophy is adopted in Bali's ICM program.

***Tara Bandu* in Timor-Leste**. Through the customary law, *Tara Bandu*, some coastal heritage areas are being protected by the communities. *Tara Bandu* is a traditional Timorese custom that enforces peace and reconciliation through the power of public agreement. It involves the hanging of a culturally significant item from a wooden shaft as a sign of a ban on certain activities within the area of concern. Given that there could be multiple resource-use conflicts in the coastal areas, *tara bandu* codes of behavior would be useful in addressing existing conflicts or in preventing outbreak of potential conflicts. It is recognized as a customary governance structure that can complement formal regulations. The Ministry of Tourism is implementing the *National Tourism*

[301] Willy Daeli, Ines Ayostina and Barakalla Robyn. 2019.

Policy 2011-2030, with consideration to the *Timor-Leste Strategic Development Plan 2011–2030*, laws/decrees related to other sectors (e.g., environment, agriculture and fisheries, land, and property, etc.), and *Tara Bandu*.[302]

In Behau (~40 km from Dili), the community has implemented *Tara Bandu* in the past, forbidding fishing in a very productive section of the reef through a combination of sacred rituals and formal legislation. The positive effects that Behau's *Tara Bandu* had on fish stocks are still remembered in the stories of fishers. Thus, to improve fishery yield, the community is now using the old tradition, *Tara Bandu*, in establishing a LMMA to protect their reef, ban anchoring and destructive fishing, and implement a zoning system, which delineates the temporary fishing closure area, and the no-take zone.[303]

The WorldFish is also helping some coastal communities in adopting the *Tara Bandu* to better regulate the use of the marine environment. In Atauro Island, for example, the communities agreed to limit certain types of activities in an allotted MPA while allowing other activities, so even as they fish less, they can collect fees directly from tourists who come to dive.[304]

Philippines. Major challenges are being faced by indigenous practices and institutions in a fast-modernizing world. There are several indigenous practices in the use, control and protection of coastal resources, such as the *vanua* and *mataw*, among traditional fishing communities in Batanes, and in Palawan. Traditional practices of fishing communities living in harmony with nature involve harnessing the ecological knowledge of fishers, observing economic arrangements to protect the environment, and implementing organizational rules, taboos and rituals formulated by the association of users.

According to Mangahas (2008): In Batanes, the Ivatan notion of a *vanua* (port) has linguistic connections to the wider Austronesian world. The term vanua in the verb form Mayvanuvanua or "making a port" refers to a sacrificial rite performed at the beginning of the summer fishing season by *mataw* fishers in Batanes. "Making the vanua" reproduces port communities of fishers competing to attract and successfully capture the fish *dorado* for a limited (seasonal) period of time. By making the vanua (Mayvanuvanua), the *mataw* transform the *vanua*, which is a natural geological feature of the landscape, into a sacred and sensitive place. The rite's symbolic elements shows ethnographically the resulting collective as an organized group of fishers under a system of government, and moreover, one which also relates to two other kinds of social groups in Batanes life: cooperative work groups (*payuhwan*) as well as groups of persons who drink together.

[302] PEMSEA and MAF, 2019. NSOC Report of Timor-Leste.
[303] Blue Ventures (https://blog.blueventures.org/en/taking-control-with-tara-bandu/)
[304] WorldFish/Tilley, A., 2016.

Batanes: Overlooking the Luzon Strait where the Pacific Ocean merges with the South China Sea. *(Photo by R. Bautista-Olfato)*

Tanah Lot temple in Bali, Indonesia *(Photo by M. Ebarvia)*

PART 5

CONCLUSION: SAVING OUR OCEAN AND ENHANCING INCLUSIVE PROSPERITY, THE BLUE ECONOMY WAY

21 Understanding and Measuring the Value of the Ocean

"The dark oceans were the womb of life.
From the protected oceans, life emerged.
We still bear in our bodies—in our blood,
in the salty bitterness of our tears—
the marks of this remote past."
Ambassador Arvid Pardo,
32nd Session of the UN General Assembly, 1 November 1967

Oceans are vital to biodiversity and ecosystems as well as to food chains, income, livelihood, shoreline protection, climate regulation, and food, water and energy security. The Ocean provides 50 percent of the air we breath, thus, our very existence depends on it. The RSOC Report provides insights to these ecosystem services and blue economy in the EAS region. The key themes on blue economy raised at the 'Rio +20' UNCSD (2012)—ocean as (a) natural capital, (b) good business, (c) integral to Small Island Developing States, and (d) small-scale fisheries livelihoods—are taken into account, and this RSOC report discusses these aspects and shows that blue economy is a way forward to reach sustainable development goals. The current state of the ocean health and ocean economy in the region are reviewed as intertwined facets, and examples of the on-going transformation towards blue economy development are highlighted. Likewise, the opportunities in improving the ocean governance structure are pointed out to enable a sustainable and resilient ocean economy and achieve economic prosperity with inclusion, ocean protection, and reduction of climate and environmental risks and ecological scarcities at the same time. As shown in this report, sustainable blue economy brings diverse stakeholders together to achieve common goals: effective protection, sustainable production, equitable prosperity, and inclusion of women, small-scale fishers, and coastal communities.

Except for the two small states of Brunei and Singapore, the EAS countries have long coastlines, and Indonesia, Japan, and the Philippines are the among the largest archipelagos in the world. This has resulted in people of this region having close relationship with the sea, as fishers or as seafarers.

Estimating the value of ocean economic activities as well as the ecosystem services would help improve understanding of the role of the oceans in the economy. The ocean economy in the region contributes to the GDP of the countries in varying degrees: 2.6 percent in RO Korea, 4.2 percent in the Philippines, 4.5 percent in Singapore, 19 percent in Viet Nam, 9.5 percent in China, 16 percent in Cambodia, 19.7 percent in Indonesia, 23 percent in Malaysia, 30 percent in Thailand, and 87 percent in Timor-Leste. The ocean economy as reported by eight countries in their SOC reports was estimated to be worth around **US$ 1.5 trillion** in value added. Around **61 million** people in the EAS Region are employed in the ocean industries. However, these ocean economic activities must be sustainable to be considered in the blue economy. Innovative technologies, new products and services, emerging industries, and demand for 'green' infrastructure and sustainable processes are reshaping the established ocean economy and offering opportunities for business and investments.

It is essential to recognize natural capital as a critical economic asset and as a source of public benefits. The oceans provide significant ecosystem services, and the net benefits have to be measured to show how the oceans and coastal and marine ecosystems support the economy and human welfare. There is a need to move towards properly accounting the worth of our ecosystems, including the intangible and nonmarket values, for proper deliberation of the full benefits, costs, and tradeoffs in political and economic decision-making. Oceans and the coastal and marine ecosystems provide important goods and services, most of which are not accounted for in the GDP of countries, such as protection from storm surge, waste assimilation, carbon sequestration, cultural services, etc. **Table 21.1** shows the value of coastal and marine ecosystem services in the EAS region.

The economic value of the seas and coasts of the EAS Region therefore comes from the rich marine resources, productive coastline, ocean industries, and ecosystem services. However, the wealth of the ocean depends on its health. Overexploitation of fish and marine resources, destruction of habitats, ocean pollution, and climate change impacts all together compound stresses on ocean health. The new paradigm on sustainable, inclusive, and resilient blue economy is key to effectively protect the ocean, while at the same time sustainably utilize the ocean resources and create inclusive and equitable prosperity for the people.

Table 21.1: Ocean Economy and Ecosystem Services.

Country	Ocean Industry (US$) GVA, (in 2015, at constant prices)	Value of Ecosystem Services (US$)
Cambodia	2.4 billion	200.42 million to 583.42 million
China	1,041.9 billion	
Indonesia	188.5 billion	403 billion to 411 billion
Malaysia	63.0 billion	17.7 billion
Philippines	11.8 billion	1.5 trillion
RO Korea*	34.6 billion	40.5 billion - 42.6 billion
Singapore	(4.5% of GDP)	
Thailand	118.2 billion	36 B
Timor Leste	1.97 billion	5.25 B
Viet Nam	29.28 billion	3.9 billion

*Source: National SOC Reports; *Chang, 2021.*

Economic growth over the past 50 years in the EAS region had been accompanied by decline in natural capital, and the ability of ecosystems to sustain services. The following are the underlying causes of the coastal and marine habitat and biodiversity loss:

- Conversion of habitats to aquaculture and agricultural farms
- Destruction due to coastal and marine infrastructure development, destructive fishing,
- Siltation and sedimentation due to deforestation, mine tailings, agricultural and urban runoff
- Pollution due to lack of sanitation, wastewater, solid waste, and plastic waste management systems and facilities
- Few MPAs established, and inadequate management system for MPAs, LMMAs, and fish sanctuaries
- Lack of protection for endangered species, and culturally important species
- Lack of monitoring system to regularly assess the status of habitats, fisheries, biodiversity, protected areas, and marine water quality
- Limited environmental inputs into the urban, infrastructure and tourism development plans
- Poverty and lack of alternative livelihood in coastal communities.

The ecosystem services stand to be lost if measures are not undertaken for ecosystem conservation and sustainable use. Southeast Asia is expected to lose one third of mangroves between 2000 and 2050 under a 'business as usual' scenario, with the value of loss estimated at US$ 2 billion, the annual value in 2050.[305] For the coral reefs, the value of lost reef-related fisheries in Southeast Asia is US$ 5.6 billion (annual value in 2050), with the highest loss in Indonesia and the Philippines.[306]

Moving forward, the blue economy provides great potential for boosting growth of environment- and climate-friendly investments, innovations, and science and technology-intensive industries. The blue economy paradigm promotes an alternative economic growth strategy in the coasts and oceans where prosperity, sustainability, inclusion and resiliency can go together. This has emerged as a feasible development path where growth in income and employment is driven by sustainable consumption and production that prevent the loss of biodiversity and ecosystem services, reduce pollution, enhance resource efficiency, and reduce carbon and water footprints. Various examples of innovative and sustainable activities are transpiring in the EAS region. Sustainable fisheries and aquaculture practices, green ports and shipping, and ecotourism involve changing practices, adopting new technologies, and shifting to the blue economy paradigm. The impact on climate change from the fossil fuel energy sector has put increasing pressure on the energy sector to invest in alternative renewable technologies, such as ocean energy and coastal and offshore wind power. Enabling conditions, good governance, and directions on ocean stewardship are crucial to sustain the momentum towards blue economy development.

[305] Brander and Eppink, 2015.
[306] Brander and Eppink, 2015.

Due to data and capacity constraints, the integrated economic-environmental accounting for the ocean (using the SEEA framework) was not applied during the development of the NSOC Reports. Nonetheless, by using both the SNA to assess the ocean economic activities, and existing studies on the valuation of ecosystems, the RSOC Report provides an initial measure of the contribution of oceans and coasts to the economy and wealth of nations in the EAS region.

Knowing the structure of the ocean economy and ecosystem services can be used to see the benefits and how environmental degradation, biodiversity loss, and climate change can affect development and human welfare. Initial estimates already show that the SOC reports provide a comprehensive approach to evaluate the contribution of oceans and coasts and impacts of human activity on the ocean, as well as monitor policies, response measures, innovations and progress in achieving the targets of the SDGs, SDS-SEA, and other international agreements. There are still huge gaps, and bold actions and collaboration are needed as we head towards 2030 where we have committed to achieve 17 goals. Thus, the SOC reporting system is an important tool to advance good governance, scientific support and partnerships for blue economy, promote the development of synergies among the various sectors, and support evidence-based policy- and decision-making aimed at ensuring sustainable oceans and coasts for all.

Mangrove restoration. *(Photo by MOEF Indonesia)*

22 Blue Economy: Shaping the Challenges of Our Time

"I need the sea because it teaches me."
Pablo Neruda

22.1 Where are We Now? Small and Big Steps Towards Blue Economy

Given the scale and the pace of global environmental and socioeconomic change, 'Business as Usual' is no longer an option. Crises can, however, provide the context and opportunities for new kinds of transformative actions and innovations, and history shows many examples of ground-breaking responses. The blue economy considers the application of viable, green or environmentally sound practices and technologies for sustainable oceans. Good governance, institutional capacity, and businesses willing to partner with policymakers, legislators, researchers, and stakeholders can help achieve targets to improve the environment and welfare of the people.

The blue economy, as adopted during the EAS Congress 2012, refers to a sustainable ocean-based economic model; one that employs environmentally-sound and innovative infrastructure, technologies, and practices, including institutional and financing arrangements, for meeting the goals of: (a) sustainable and inclusive development and poverty alleviation; (b) protecting our coasts and oceans and reducing environmental risks and ecological scarcities; (c) addressing food, water, and energy security through sustainable ocean economic activities; (d) protecting the health, livelihoods, and welfare of the people, especially those in the coastal zone; and (e) addressing the ocean-climate nexus by fostering ecosystem-based climate change mitigation and adaptation measures.

Sustainable, inclusive and resilient blue economy is a carefully planned strategy to embrace growth while using resources more efficiently, with utmost consideration of immediate AND long-term impacts on the ocean and the benefits for our planet and the humans who live on it. Ocean economy growth prospects are huge if transformative action is taken to achieve sustainability and security.

Examples of transformative actions and emerging sectors in the ocean economy in transitioning towards blue economy development as well as policies and governance mechanisms supporting such national and regional efforts are shown in **Table 22.1**. These initiatives demonstrate that solution options are available, and good and responsible business in oceans is possible.

Table 22.1: Blue Economy Development.

Ocean Economic Activities	Emerging Sectors	Transition To Blue Economy	
		Blue Economy Initiatives	Policies and Governance
1. Fisheries and aquaculture	• Offshore aquaculture • Seaweed farming at industrial scale	• Climate smart aquaculture (Viet Nam, Philippines) • IMTA and marine ranch (China, RO Korea, YSLME) • Sustainable tuna fisheries (WCPFC, Indonesia, Philippines, Viet Nam)	• International agreements: UNCLOS; UN Fish Stocks Agreement; FAO Port State Measures Agreement (on IUU Fishing); Ramsar Convention on Wetlands • Regional and National Plan of Action on IUU Fishing • Regional Action Plan to address overfishing of neritic tuna • National Tuna Management Plans (Indonesia, Philippines, Viet Nam) • Ecosystem Approach to Fisheries Management • Control, Monitoring, and Surveillance system; Electronic catch documentation and traceability system; Registration of fisherfolk and fishing vessels • Pollution monitoring of aquaculture farms • Conservation: Establishment of fish sanctuaries and MPAs; closed season and fishing ban of certain species; output controls (e.g., total allowable catch) • Incentives: Certification from Marine Stewardship Council; Government-funded R&D
2. Coastal and marine tourism	• Cruise tourism; theme cruises (but negative impacts have to be addressed)	• Ecotourism (Malaysia; Philippines; Viet Nam) • Marine parks (Malaysia , Indonesia, Cambodia, Timor-Leste) • Zero carbon resorts (Philippines; Thailand) • Wastewater treatment and reuse (Indonesia, Philippines, Thailand) • Green Fins (Thailand; Philippines; Viet Nam)	• Ecotourism policy and strategic action plan • MSP; Coastal use plan and zoning schemes • Beach management • Financing: environmental user fees (collected from tourists); conservation charge; hotel guests contribute to habitat conservation financing • Incentives: UNESCO World Heritage Sites; ASEAN Heritage Parks – for conservation and sustainable tourism
3. Ports and shipping	• Green ports • Green ships	• Green ports (waste management; energy efficiency; reduced sulphur and GHG emissions; etc.) • Shore reception facilities • Shore-based power supply using renewable energy • Infrastructure for ballast water management • Green ships	• Adoption of international conventions (e.g., MARPOL, London, Basel, CITES, etc.); decarbonization targets • Green ports index and Green Awards for ships • World Ports Climate Initiative • Port Safety, Health and Environmental Management Systems (PSHEMS) • Joint oil spill response (Gulf of Thailand; ASEAN; NOWPAP)

Table 22.1: Blue Economy Development. (cont.)

Ocean Economic Activities	Emerging Sectors	Transition To Blue Economy	
		Blue Economy Initiatives	Policies and Governance
			• Incentives: Green Port Award System (APEC); Green Award for ships; fiscal incentives and tax benefits (Singapore); incentives provided by ports to Green Award certified ships (Japan and China) • Emission control areas, which require ships to use fuel with 80 percent less sulphur (China)
4. Offshore oil and gas		• Phasing out of coal, and increasing investments in renewable energy	• Monitoring of water quality and sediments in the area of offshore oil rigs (Timor-Leste and Australia)
5. Energy	• Marine renewable energy	• Ocean energy – tide, current, OTEC (Korea) • Coastal and offshore wind power (China, Viet Nam, Thailand, Philippines)	• Policies and Action Plans on marine renewable energy • Incentives: feed in tariff • Government-funded research, development and deployment • Partnership with private sector
6. Water supply		• Desalination with reuse of brine • Deep seawater utilization • Wastewater treatment and reuse	• National laws on water and wastewater management
7. Shipbuilding	• Clean/green ships		• Incentives and R&D: environment- and climate-friendly technologies to increase energy efficiency, reduce GHG emissions and operational cost
8. Seafood processing			• Post-harvest facilities; monitoring of the supply chain; ensuring sustainably sourced fish, crustaceans, etc.
9. Marine biotechnology	• Marine biotechnology for new medicines, bioremediation, energy		• Government-funded R&D: Marine biotechnology for new medicines (Philippines, RO Korea, China), food, energy, and bioremediation
10. Marine communications	• Fiber optics		
11. Marine construction	• Climate-resilient infrastructure	• Low impact and green infrastructure	• Climate financing
12. Marine services	• Technology-based maritime logistics • Digitalization • Automation	• Coastal and marine ecosystem-based climate insurance • Blue bonds • Blue carbon markets	

Table 22.1: Blue Economy Development. (cont.)

Ocean Economic Activities	Emerging Sectors	Transition To Blue Economy	
		Blue Economy Initiatives	Policies and Governance
13. Public/ government	• Marine environmental protection and ecosystem conservation • Ocean mapping and observations • Marine research • Ocean-climate financing	• Regional and National Strategic Action Plans • Ecosystem-based fisheries management • Habitat restoration • MPAs, MPA networks, marine parks • Co-management arrangements and alternative livelihood • Ocean financing; biodiversity conservation financing • Market-based instruments (e.g., carbon tax, emission trading system, payment for ecosystem services, environmental user fees, etc.) • Marine plastic management initiatives	
	Circular economy: • Wastewater treatment plants with facilities for reuse applications • Marine plastic waste management and marine debris management	• Singapore: tough anti-littering laws, integrated solid waste management; Singapore Packaging Agreement • Indonesia: National Action Plan on Marine Plastic Debris • Japan: marine litter research; heavily-subsidized cleanup • Philippines: National Sewerage and Septage Management Plan and Program; >PhP3 billion investment by concessionaires • RO Korea: Coastal Total Pollutant Load Control System • Wastewater reuse: for potable and non-potable uses (Singapore); for irrigation (Viet Nam; China); sludge as soil conditioner (Philippines; China; Japan); recovered methane as fuel for buses and trains (Japan)	

Table 22.2: Examples of Blue Economy Initiatives of Countries.

Country	Blue Economy Initiatives
Cambodia	• Sustainable tourism in Sihanoukville: zoning of beach for business area, green space, public access, and sanitation facilities; solid waste management; MPA in Koh Rong islands • Sustainable port in Sihanoukville: implementation of the Port Safety, Health and Environmental Management System (PSHEMS) • Mangrove restoration; seagrass and dugong conservation • Solid waste and wastewater management in Sihanoukville: garbage collection and landfill; wastewater treatment plant
China	• Fisheries: IMTA, marine ranching • Green ports • Marine renewable energy (offshore and coastal wind power; ocean energy) • Desalination with reuse of brine • Ecological Remediation Project of "Developing mangrove forests in the south and Chinese tamarisk forests in the north" • Shandong province: artificial reefs; zoning for coastal sightseeing and fishing; and marine ranching for aquaculture, breeding of benthic fish, etc.
Indonesia	• Green ports: PT Terminal Teluk Lamong • Ecotourism and MPAs • Mangrove restoration and coral reef rehabilitation • PROPER program: compliance of industries to pollution regulations and awarding/recognition system • National Action Plan on Plastic Waste Management, 2017-2025

Table 22.2: Examples of Blue Economy Initiatives of Countries. (cont.)

Country	Blue Economy Initiatives
RO Korea	• Sustainable fisheries: Fishery Resources Protection Zone; TAC program; Marine ranching • Comprehensive Plan for Green Busan Port • Shipbuilding of green ships • Wetland conservation sites • Marine protected areas • Coastal Total Pollutant Load Control System: in Masan Bay (2008) › Siwha-Incheon (2013) › Busan (2015) › Ulsan (2017) › Gwangyang (2019)
Malaysia	• Marine parks and ecotourism • Green ports • Sustainable marine aquaculture • Sustainable fisheries: stock assessment; management strategies e.g., zonation, gear based, licensing, monitoring and enforcement • Alternative livelihood: seaweed cultivation; tourism • Climate change response: National Coastal Vulnerability Index study; Implementation of the Integrated Shoreline Management Plan; Adaptation measures
Philippines	• Sustainable fisheries: amended Fisheries Code; ecosystem approach to fisheries management; 10-Year Plan of Action to address IUU fishing; registration of fisherfolk, fishing vessels and gears; conservation of blue crabs and swordfish; closed season for sardines and small pelagics; ban on sargassum and black corals • Sustainable tourism: National Ecotourism Strategy and Action Plan (2013-2022); Zero Carbon Resorts; Green Fins program; MPA/tourism branding; marine and coastal heritage sites and parks • Green ports • Coastal wind power; R&D on ocean energy • Marine biotechnology • Ecosystem conservation: Mangrove and Beach Forest Development Project; coral reef rehabilitation; SmartSeas Program; MPA Network for sea turtles • Wastewater and septage management
Singapore	• Green Ports • R&D on ocean energy • Marine biotechnology for aquaculture • Wastewater treatment and reuse • Integrated solid waste management • Singapore Packaging Agreement with industry
Thailand	• Laem Phak Bia Project in Phetchaburi province: simple, natural, and low cost wastewater and waste treatment models ideal for Thai communities • Low carbon tourist destination project in Koh Mak, Trat Province: Using alternative energy, waste management, and preserve traditional way of life • Bor Hin farmstay in Amphor Sikao, Trang province: ecotourism, mangrove reforestation, Seagrass Seeding Bank • Crab Bank Model in Chumporn and Surat Thani: Education, Stock assessment and co-management with fisher communities
Timor Leste	• Sustainable fisheries and aquaculture: integrated system for tilapia, milkfish, etc. • MPAs: 3 MPAs in Atauro (Vila, Adara, Varuana); 5 MPAs in Nino Konis Santana National Park; new sites in Bobonaro • Mangrove rehabilitation • Solid waste management: Ecobank and Green School program
Viet Nam	• Climate-smart aquaculture • Ecotourism with habitat conservation • Marine plastic management • Mangrove restoration in Ca Mau and Tien Giang province • Biodiversity conservation to respond to climate change • Green growth for 28 coastal provinces in Viet Nam

22.2 Where are We Heading? Make Blue Economy Happen

1. Common understanding of blue economy: Lay the foundation.

It is essential to increase awareness of the value of the ocean and pressures on ocean health, and foster a shared understanding of blue economy to secure a future where equitable prosperity, ocean protection, sustainable use of ocean, and climate resiliency go together.

The EAS Region is a trailblazer in blue economy development, from the adoption of the SDS-SEA in 2003 to the signing of the Changwon Declaration 2012 espousing the blue economy paradigm, and to the preparation of the national and regional SOC Reports for assessing progress. But there is still a huge gap in recognizing the interconnected ocean economic activities, ecosystem services, and the values and benefits of well-managed marine and coastal habitats and fishery resources and clean sea to enhance economic efficiency, generate jobs, and achieve sustainability, resiliency, and security.

2. Ocean accounts: Know and value what you have.

There is a need to transform the 'growth' paradigm, and highlight the value and contribution of natural oceanic capital to guide the policy decisions that consider trade-offs and complementarities of different ocean sectors, environment protection and resource conservation.

To make informed choices and ensure sustainability of ocean wealth, it is of utmost importance to institutionalize *ocean monitoring* and *ocean accounting*. What gets monitored and measured, gets managed. We tend to value what we have measured, but there are so many goods and services provided by nature, especially by the ocean, that are not measured. This has affected the choices we make as a society. Healthy ocean and marine ecosystems are essential to life. **We need to measure what we value so we can properly manage them**.

The marine and coastal ecosystems are regarded as a 'blue diamond' in recognition of its significant 'value' and is an asset, which if invested in properly, will return or repay dividends over time, but can be lost forever if management interventions and actions needed to protect them are not taken now. Knowing the economic worth of ecosystem services (in monetary terms) can help ensure that those who rely heavily on ecosystems – from fishers to governments, industries and businesses – see their value and integrate sustainability, waste management, and conservation in their planning and use. Good data is the foundation of good decision-making and management.

The development of ocean accounts enables decision makers to track whether policies, economic activities and investments are building ocean wealth for future generations. **Ocean accounts operate as a sustainable development scorecard for the blue economy**.

It is therefore critical to improve the statistical and methodological base at national and regional levels for measuring the ocean economy, scale and performance of ocean-based and ocean-related economic activities, value of coastal and marine ecosystem services, as well as the depreciation/appreciation of coastal resources, environmental damage, and the economic-environmental linkages in the ocean. Resources and capacity are needed to develop the ocean accounts following the UN System of Environmental-Economic Accounting (SEEA) approach. Current national income accounts do not have the breakdown for the ocean economic activities and disaggregated data are not available in most sectors (e.g., small-scale fisheries, coastal and marine tourism, maritime shipping, maritime services, etc.). Together with the development of ocean accounts, there should also be assessment of the value added of blue economy initiatives, backward and forward linkages of all ocean economic activities, and the multiplier effects. Regular monitoring and resource accounting for mangroves, seagrass, coral reefs, and fisheries have not been done in most countries in the region. Coastal and marine ecosystem accounting should be an integral part of the ocean accounts. Moreover, there is also lack of waste accounting, and studies showing the environmental cost and economic losses from unsustainable activities.

3. Ocean governance: Enable blue economy development and protect ocean health.

Among the greatest threat to the blue economy is the general lack of knowledge or accountability regarding the value of goods and services originating from the sea.[307] Coastal and marine ecosystems provide the natural capital and inputs for the ocean industries. They are essential in securing food, energy, water and other resources, and securing people and communities from impacts of climate change. Yet, countries have not given priority to the ocean. Most countries in the region still lack a national ocean law or policy and a dedicated institution to manage and coordinate the different ocean economic activities and the implementation of ocean protection measures.

- **Adopt national ocean policies that advocate integrated ocean management and sustainable, resilient, and inclusive blue economy development.**
  - Identify entry points, new business models, revenue streams and financing mechanisms that can be leveraged to accelerate blue economy investments (e.g., sustainable fisheries, aquaculture and seafood processing, sustainable ecotourism, green ports, green ships, shipbuilding and marine engineering, marine renewable energy, marine biotechnology, etc.) and protection of the marine environment and ecosystems (e.g., wastewater and solid waste management, plastic use reduction and recycling, GHG emission reduction, restoration of coastal and marine habitats, and establishment of MPAs)
  - Strengthen integrated coastal and ocean management, and put in place long-term strategies, practical and viable action plans for the short to medium term, institutional arrangements, supporting financing mechanisms, and M&E system, taking into consideration the shared vision and desired outcomes of stakeholders.

[307] UNCTAD, 2018.

- Support knowledge management and capacity development of institutions at the national and local levels to enable adoption, implementation and sustainability of ocean health protection measures, and innovative blue economy initiatives.
- Connect blue economy initiatives to the achievement of the SDGs: Show the synergies to accelerate actions and achieve the targets of the SDGs, SDS-SEA, and other international and regional agreements.

- **Harmonize policies, procedures, incentives and financing modalities to provide for the sustainable use of coastal and marine resources and protection of ocean health**, such as:
  - Marine spatial planning, including mix of regulations and economic instruments
  - MPAs that are well-designed, more effectively managed, cover key biodiversity areas, and consider the interconnectedness of mangrove forests, seagrass beds, coral reefs, and other coastal and marine ecosystems.
  - Habitat restoration and conservation with co-management arrangements and biodiversity-friendly livelihood and enterprises in coastal communities. Coordination of ICM and river basin and integrated water resource management programs, including reforestation and protection of watersheds to ensure freshwater flows, and reduce siltation and sedimentation.
  - Monitoring, control and surveillance (MCS) system, post-harvest facilities, value-adding industries and eco-labelling to support sustainable fisheries and aquaculture
  - More investments in wastewater, solid waste, and plastic waste management systems, including facilities for recycling and reuse, to reduce marine pollution
  - Determined promotion of 3Rs (reduce, reuse and recycle) for solid and plastic waste management in communities, businesses and institutions
  - Shift to low carbon/zero-carbon, energy-efficient, and green technologies
  - Low impact and climate-resilient development and green infrastructure in coastal areas
  - Blue carbon programs to enhance climate change mitigation efforts

- **Ensure clear regulations, consistently enforce the law, provide awards and incentives for compliance, and conduct regular monitoring** of: (a) water quality of coastal and marine water bodies and major rivers, pollution loadings from major sources, and compliance to standards, (b) condition of habitats and biodiversity, (c) fish stocks, (d) impacts of economic activities on water quality and ecosystems; (e) status and outcomes of research; and (f) projects, tools and processes applied in addressing major threats and their outcomes.

- **Promote the equitable sharing of benefits** derived from the use of marine resources and biodiversity by (a) establishing clear rights of access, use, and ownership over marine space and resources, (b) leveraging traditional ecological knowledge, and (c) encouraging benefit-sharing and co-management systems.

- **Increase public awareness and engage the various stakeholders.** Public environmental awareness is a primary concern of the future of humanity. Ocean awareness means to understand the fragility of our ocean and the importance of its protection. Environmental degradation, habitat and biodiversity loss, overfishing and destructive fishing, and climate change cannot be prevented by laws alone. Public participation is equally imperative with regard to environmental protection. However, it is critical to raise public awareness in order to stimulate behavioral change, increase public support, accelerate participation of various stakeholders, and mobilize local knowledge and resources. Awareness raising and mobilizing the stakeholders require strategies of effective information, education, and communication (IEC), dissemination of knowledge products, and use of social media to reach the desired outcome. More importantly is for everyone to recognize, understand, and respect the challenges present at every level, and act accordingly to address them.

Table 22.3: Recommendations to Support Blue Economy Development.

	Recommendations
Fisheries and aquaculture	• Invest in fisheries monitoring, data collection, fish stock assessment, fisheries accounting, climate resiliency, and sustainable, ecosystem-based management plans • To deter and end IUU fishing, strengthen MCS systems and port measures, implement e-CDT system, use trade sanctions or strengthen import controls to ensure legal and sustainable products from exporting countries • Establish well-designed and effectively managed MPAs and fish sanctuaries, including no-take zones and closed fishing season for certain species • Invest in innovative R&D to address key challenges in aquaculture sector • Ensure right stocking densities in aquaculture farms to reduce nutrient wastes, and minimize the risk of disease outbreaks and transmission and use of antibiotics. • Reduce post-harvest losses and promote value-added processing to generate more wealth for locals
Coastal and marine tourism	• Promote regional cooperation on responsible codes of conduct for travel providers and best practices to reduce negative impacts from tourism • Use policy instruments, such as MSP, and regulations on waste management, water and energy use, and habitat protection, and application of market-based instruments (e.g., taxes, awards) • Consider how blue carbon trading schemes can dovetail with ecotourism and MPAs • Require inclusive and integrated planning and EIA before any tourist-related development approval. • Ensure public access to beachfront and provide ways for locals to benefit from sustainable tourism.
Ports and shipping	• Adopt a uniform set of blue economy standards, such as green ports and green ships • Allow for flexibility in how standards and GHG emission reductions are to be met – enforce via blend of incentives and command-and-control instruments • Regional shipping companies and shipbuilders to require minimum port and shipping standards in the areas of efficiency, cost reduction, and safety, health and environmental management
Marine renewable energy	• Provide R&D funding and incentives to support technological innovation, deployment, and commercialization of MRE to make them cheaper relative to fossil fuel
Marine pollution	• Make wastewater and solid waste a resource. Promote the circular economy by showing the returns from reuse and recycling. • Accelerate waste management solutions and access to technologies and financing to reduce marine plastic debris • Initiate Extended Producer Responsibility (EPR) schemes and incentives: manufacturers and importers should bear the costs of reuse or disposal

Source: PEMSEA. 2018. Policy Review Briefs for Blue Economy.

4. Get the private sector as investors and partners in environmental investments

Private sector can be (a) an investor providing the capital financing needed for environmental investment and biodiversity conservation, (b) service provider (design, build, operate, and/or manage facilities, e.g., waste collection and treatment, wastewater management, recycling, etc.), (c) industry or company owners (e.g., commercial fisheries, aquaculture farms, tourism establishments, shipping and shipbuilding companies, water and energy utilities, etc.), and (d) partner in co-management of conservation and protected areas. Private sector can fill in the gaps in financing, and technical and business expertise.

Nevertheless, private sector participation is not the panacea to the range of blue economy and ocean sustainability issues. There are public goods and externality issues in ocean investments. While project proponents from the local government/ICM sites need to identify, develop, and package bankable investments that provide a financial return to the capital and service providers from the private sector, there should be clear understanding that the investments should also deliver positive social and environmental impact on coasts and ocean. Local governments should put in place the enabling conditions that will not just attract private sector participation, but also commit the private sector to key performance indicators covering more cost-effective and efficient production or services without harming the climate and ocean health. There has to be trust and commitment on both sides.

Accessing private capital financing, technical and business expertise is well understood, but how to access financing and technologies and select among the various choices are major issues, especially for local governments.

The national/central government can provide the overall policy framework and directions for environmental investments, ensure stable macroeconomic fundamentals, and support the local governments, including providing subsidies and capacity development.

International financing institutions, donors, NGOs can provide technical assistance, share knowledge, and help local governments and local stakeholders develop their capacity to identify and package projects, access technologies and financing, and improve the governance structure.

Local governments, on the other hand, should understand the need for blue economy investments, and make them their priority. They should be willing to learn and develop their capacity, in the shortest time possible, to: (a) identify and package bankable investments, (b) institute enabling conditions and improve the ease of doing business in their jurisdiction, and (c) set the ground rules, and enforce laws and regulations in a consistent way. Objectives (b) and (c) are the usual good governance measures while objective (a) involves a different expertise, and one that requires willingness of the local government to be innovative, to learn new technical, business, and managerial skills, and go beyond the traditional scope of governance. While it usually takes time, if there are leaders with political will, champions for the ocean and blue economy, and public support, then blue economy investments can happen.

There are already examples in the region (and other regions), which demonstrate actions that not only reduce risks and draw in the needed financing and investments for the required infrastructure, facilities, and services, but also result in more stable and fruitful partnerships towards an overall sustainable and efficient management of the ocean.

5. Ocean science and traditional knowledge: Apply these tools to transform to a better future.

Scientific research, experimentation, data collection, monitoring, and modeling provide the knowledge and frameworks needed to model and analyze the environmental consequences of ocean economic activities and other human activities, policy, and development proposals. Such information allows us to chart a sustainable future ocean.

Foster Science-Economy-Policy linkage and harness the information from ocean science and ocean accounts to develop and implement evidence-based policies, plans, and measures needed to transform to blue economy and ensure healthy ocean and people.

Provide or access financing for research, development and deployment (RD&D) and testbed platforms, and provide incentives for commercialization of new technologies that are crucial in transforming established ocean industries to become more sustainable, productive and efficient, and in advancing the emerging ocean economy industries as well as decarbonization, plastic recycling, alternatives to plastics, and cost-effective technologies in wastewater treatment to allow reuse and recovery of water, energy and nutrients. Assess how digitalization, big data analysis, internet of things, artificial intelligence, blockchain, etc. can be used as enablers of more efficient, sustainable and resilient blue economy.

Improve and ensure access to technologies and supporting funds, and support technology transfer, capacity development, and knowledge management to increase uptake of frontier technologies and their application in blue economy sectors, climate action, and protection of ocean health.

Not all knowledge are new. **Protect traditional knowledge and culture, and integrate them in policies and plans**. The traditional ecological practices have been proven to enhance biodiversity, and aids in maintaining healthy ecosystems. Marine resource utilization through traditional methods and local knowledge have resulted in stable fish stocks and marine conservation practices—a win-win for the environment, livelihood, food security, and resiliency.

Develop knowledge tools and products and simplify scientific and economic information to increase awareness and understanding about the ocean issues, role and responsibilities of people in blue economy development and protection of ocean health, and the benefits to be derived if measures and actions to reverse environmental degradation and climate change are done.

6. Regular SOC Reporting: Assess progress, gaps, and opportunities.

The RSOC and first set of NSOC reports provide the baseline for future assessments. Initial estimates show that the SOC Reports provide a comprehensive approach to evaluate the contribution of oceans and coasts to prosperity, security, and wellbeing, assess the pressures and impacts of human activities on the ocean, as well as monitor progress towards the SDGs, SDS-SEA, and other international agreements through the blue economy and ocean governance initiatives.

The SOC reports are an important tool to advance scientific support, raise public awareness, promote good governance and partnerships for blue economy, and create the development of synergies among the various sectors and stakeholders to address gaps and needs. The evidence base provided by the SOC reports is significant and fundamental in informing policy- and decision-makers on ocean-related issues as well as outcomes of interventions and investments that work, and best practices that can be replicated and scaled up. Innovations, new technologies, and ocean financing mechanisms are also emphasized in the SOC reports to show opportunities to transform to blue economy while ensuring healthy oceans.

With the signing of the *Iloilo Ministerial Declaration* in 2018, partners of PEMSEA has committed to the regular updating of the SOC reports to highlight the contributions of coasts and oceans, measure the impact of initiatives on ocean health and blue economy development, and identify opportunities for partnerships, financing, environmental investments, capacity development, and knowledge sharing. Acknowledging the significant role of the ocean in national development and protecting lives, livelihood and wellbeing of the people, while also understanding the importance of maintaining the health of the ocean, the sustainable, resilient and inclusive blue economy is the only way forward in respect of ocean management to achieve healthy ocean, people, and economies.

(Photo from Thailand Environment Institute)

Bibliography

Agardy T., Alder J., Dayton P. and others. 2005. Chapter 19, Coastal Systems. In: Ecosystems and Human Well-being: Volume 1: Current State and Trends. Baker J., Moreno Casasola P., Lugo A., Suárez Rodrıguez A., Ling Tang, L.D. Eds. Pp. 513-549.

Alongi, D.M. 2020. "Global Significance of Mangrove Blue Carbon in Climate Change Mitigation," *Science*. https://www.mdpi.com. (doi: 10.3390/sci2030067)

Alongi, D.M. (editor), Edyvane, K., do Ceu Guterres, M.O., Pranowo, W.S., Wirasantosa, S. and Wasson, R. 2011. Biophysical Profile of the Arafura and Timor Seas. Report prepared for the Arafura Timor Seas Ecosystem Action (ATSEA) Program. 32ps.

ANSA McAL. 2011. "ANSA McAL Performer Series 2011 – Chris Maraj." Accessed from: https://www.ansamcal.com/news/ansa-mcal-performer-series-2011-chris-maraj/

Asian Development Bank (ADB). 2020. "The Role of Ocean Finance in Transitioning to a Blue Economy in Asia and the Pacific," Development Asia, 8 June 2020.

ADB. 2016. Sanitation and Sustainable Development in Japan: Evolution of Policy and Financing Mechanisms. Mandaluyong City.

ADB. 2014. *From Toilets to Rivers: Experiences, New Opportunities, and Innovative Solutions*. Mandaluyong City: ADB.

ADB. 2014. *Regional State of the Coral Triangle*. Mandaluyong City: ADB.

ADB. 2009. *The Economics of Climate Change in Southeast Asia: A Regional Review*. Mandaluyong City: ADB.

American Society of Mechanical Engineers (ASME). 2020.

ASEAN Centre for Biodiversity (ACB). 2010. *Biodiversity Outlook*. Philippines: Dolmar Press, Inc.

ACB http://chm.aseanbiodiversity.org/index.php?option=com_content&view=article&id=169&Itemid=169

Arellano, Francisco. 2014. *Comparison of Different Technology Options*. PowerPoint presentation prepared for the Joint ADB-World Bank Workshop on Wastewater Management, 27-29 January 2014. Asian Development Bank. Manila, Philippines.

ATSEA. 2012. Transboundary Diagnostic Analysis for the Arafura and Timor Seas Region.

Azanza, R., *et al*. 2017. Valuing and Managing the Philippines' Marine Resources toward a Prosperous Ocean-based Blue Economy.

Barter, M.A. 2005. *Yellow Sea – driven priorities for Australian shorebird researchers*. pp. 158–160 in: "Status and Conservation of Shorebirds in the East Asian – Australasian Flyway". Proceedings of the Australasian Shorebird Conference, 13–15 December 2003, Canberra, Australia. International Wader Studies 17. Sydney.

Barter, M.A. 2002. *Shorebirds of the Yellow Sea – importance, threats and conservation status*. Wetlands International Global Series Vol. 9. International Wader Studies Vol. 12. Canberra ISBN 90-5882-009-2.

Bedulli, Camila, Paul S. Lavery, Matt Harvey, Carlos M. Duarte, and Oscar Serrano. 2020. "Contribution of Seagrass Blue Carbon Toward Carbon Neutral Policies in a Touristic and Environmentally-Friendly Island," *Frontiers in Marine Science*, 24 January 2020. Downloaded from: https://doi.org/10.3389/fmars.2020.00001

Bersales, L.G.S., Ilarina, V.R., Poquiz, J.L.S., Raviz, J.A., and De Las Alas, J. 2019. Measuring the Ocean Economy: Towards the Compilation of the Philippine Ocean Economy Satellite Accounts. Paper presented at the 14th National Congress on Statistics (1-3 Oct 2019, Quezon City).

Bertelli, Chiara M., James C. Bull, Leanne C. Cullen-Unsworth, and Richard K. F. Unsworth. 2021. "Unravelling the Spatial and Temporal Plasticity of Eelgrass Meadows," *Frontiers in Plant Science*, 20 May 2021. Downloaded from: https://doi.org/10.3389/fpls.2021.664523

Björk M., Short F., Mcleod, E. and Beer, S. 2008. Managing Seagrasses for Resilience to Climate Change. IUCN, Gland, Switzerland. 56pp.

Boggs, G., K. Edyvane. N. de Carvalho, S. Penny, J. Rouwenhorst, P.Brocklehurst, I. Cowie, C. Barreto, A. Amaral N. Smit, J. Monteiro, P. Pinto, R Mau , J. Amaral and L. Fernandes. 2009. Marine and Coastal Habitat Mapping in Timor-Leste (North Coast) – Final Report. Ministry of Agriculture and Fisheries, Government of Timor-Leste.

Bossio, D. A., S. C. Cook-Patton, P. W. Ellis, J. Fargione, J. Sanderman, P. Smith, S. Wood, et al. 2020. "The Role of Soil Carbon in Natural Climate Solutions." *Nature Sustainability*. https://doi.org/10.1038/s41893-020-0491-z.

Boyd, A. 2017. "Sinking feeling for ASEAN fisheries." Asia Times, 3 August 2017. Available from: http://www.atimes.com/article/sinking-feeling-asean-fisheries/ [Accessed 2017 September 19]

Brander, Luke and Eppink, Florian. 2015. *The Economics of Ecosystems and Biodiversity in Southeast Asia (ASEAN TEEB)*. Scoping Study. ASEAN Centre for Biodiversity.

Brun, F.G., I. Hernández, J.J. Vergara, G. Peralta, J.L. Pérez-Lloréns. 2006. "Assessing the toxicity of ammonium pulses to the survival and growth of *Zostera noltii*," *Marine Ecology Progress Series*, 225: 177-187.

Cao Le Quyen. 2015. *Science and Technology Advantages: An important mean for Blue Aquaculture Development in Vietnam. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam*, 16-21 Nov 2015.

Campbell, Uma. 2019. Technologies to Make the Ultimate Green Ship. Biofriendly Planet. (https://biofriendlyplanet.com/green-ideas/green/technologies-to-make-the-ultimate-green-ship/)

Carpenter, K.E. & Springer, V.G. 2005. The center of the center of marine shore fish biodiversity: the Philippine Islands. *Environmental Biology of Fishes* 72: 467. doi:10.1007/s10641-004-3154-4

Carr, Lizzie. 2020. Reducing Single-Use Plastic Pollution: A Unified Approach. UN Chronicle. Downloaded from: https://www.un.org/en/un-chronicle/reducing-single-use-plastic-pollution-unified-approach

Carruthers, T. J. B., Dennison, W. C., Kendrick, G. A., Waycott, M., Walker, D. I., and Cambridge, M. L. (2007). Seagrasses of south–west Australia: a conceptual synthesis of the world's most diverse and extensive seagrass meadows. J. Exp. *Mar. Biol. Ecol*. 350, 21–45.

Center for Strategic and International Studies. 2021. China's Opaque Shipyards Should Raise Red Flags for Foreign Companies. Downloaded from: https://www.csis.org/analysis/chinas-opaque-shipyards-should-raise-red-flags-foreign-companies.

Chang, Jeong-In. 2021. "Analysis on Ocean Economy Using Input-Output Tables and Progress on a Satellite Account." Powerpoint presentation at the 5th Symposium on the Oceans in the National Income Accounts, Galway, Ireland, 24-25 March 2021.

Chang Jeong-In. 2015. "A Preliminary Assessment of the Blue Economy in Korea." PowerPoint presented in the Inception Workshop on Blue Economy Assessment, Manila, 28-30 July 2015.

Choesin., Devi, N., Rosleine, D., Pratama, M.F., Kendali, M., and Maria, B, (2021). Valuation of Ecosystem Services in the Arafura and Timor Seas Region. Report to the Arafura and Timor Seas Ecosystem Action Phase 2 (ATSEA-2) Project, Yayasan Konservasi Alam Nusantara and Coral Triangle Center, Indonesia. 45p.

Concepcion, G.P. 2008. "Marine Biodiversity and Marine Biotechnology: A Philippine Competitive Advantage," *Selected Essays on Science and Technology for Securing a Better Philippines*. Department of Science and Technology.

Corbett, J. J. *et al*. 2007. "Mortality from ship emissions: a global assessment," *Environmental Science and Technology*. 41, 8512.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., et al. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253–260.

CRC Reef Research Centre. 2004. Current State of Knowledge: Seagrasses in Queensland Waters

Crooks, S., von Unger, M., Schile, L., Allen, C. & Whisnant, R. 2017. Understanding Strategic Blue Carbon Opportunities in the Seas of East Asia. Report by Silvestrum Climate Associates for Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Conservation International and The Nature Conservancy, with support from the Global Environment Facility and United Nations Development Program.

Cuthbert, R.N. *et al*. 2021. "Global economic cost of aquatic invasive alien species," Science of the Total Environment, vol 775 (25 June 2021). Elsevier. (https://doi.org/10.1016/j.scitotenv.2021.145238)

Daeli, Willy, Ines Ayostina and Barakalla Robyn. 2019. "*Sasi Laut*" for Marine Conservation Practices in Eastern Indonesia. Downloaded from: https://wri-indonesia.org/en/blog/sasi-laut-marine-conservation-practices-eastern-indonesia

Daichi Mishima. 2021. "$5.6bn green fund to buy LNG-powered vessels for Japan's shippers," Nikkei Asia (26 February 2021).

Dasgupta, Soumyajit. 2019. What are Non Ballast or Ballast Free Ships? Marine Environment, 24 December 2019. https://www.marineinsight.com/environment/what-are-non-ballast-or-ballast-free-ships/

Davis, River and Tsuyoshi Inajima. 2021. "First Autonomous Cargo Ship Faces Test With 236-Mile Voyage," Bloomberg (August 31, 2021). https://www.bloomberg.com/news/articles/2021-08-30/first-autonomous-cargo-ship-faces-test-with-236-mile-voyage

De Deckker, P, Tapper, NJ & van der Kaars, S 2003, 'The status of the Indo-Pacific Warm Pool and adjacent land at the Last Glacial Maximum', *Global and Planetary Change*, vol. 35, pp 25-35.

Duarte, C. M., Middelburg, J. J., and Caraco, N. 2005. Major role of marine vegetation on the oceanic carbon cycle. *Biogeosci. Discuss*. 1, 659–679.

Duarte, C.M. and Kirkman, H. 2001. Methods for the measurement of seagrass abundance and depth distribution. In: F.T. Short and R.G. Coles (eds.) Global Seagrass Research Methods, Elsevier Science B.V., Amsterdam, pp. 141-154.

Duarte, C. M. 2000. Marine biodiversity and ecosystem services: an elusive link. J. *Exp. Mar. Biol. Ecol*. 250, 117–131.

Ebarvia, Maria Corazon. 2016. "Economic Assessment of Oceans for Sustainable Blue Economy Development," *Journal of Ocean and Coastal Economics*, Vol. 2, February 2016.

Ebarvia, Maria Corazon. 2015. *Blue Economy: Where are we now? Where are we headed?*. Quezon City: PEMSEA.

European Commission. 2020. The EU Blue Economy Report. 2020. Publications Office of the European Union. Luxembourg.

European Space Agency, 2006. Earth from Space: The Yellow Sea of China. (https://www.esa.int/Applications/Observing_the_Earth/Earth_from_Space_The_Yellow_Sea_of_China)

EU Waste Framework Directive (Directive 2008/98/EC on waste): https://ec.europa.eu/environment/waste/framework/

Fahrudin, Achmad. 2015. *Indonesian Ocean Economy and Ocean Health*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Fisheries and Agriculture Organization of the United Nations (FAO). 2020. *The State of World Fisheries and Aquaculture 2020. Sustainability in action*. Rome: FAO. https://doi.org/10.4060/ca9229en

FAO. 2018. *State of Fisheries and Aquaculture*. Rome: FAO.

FAO. 2017. *Fishery and Aquaculture Statistics*. Rome: FAO.

FAO. 2017. *FAO Fisheries and Aquaculture Country Profiles, Cambodia* Available online at: http://www.fao.org/fishery/facp/KHM/en (Accessed December 7, 2018).

FAO. 2015. *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*. Rome: FAO, 18.

FAO. 2015b. *A Review of Women's Access to Fish in Small-scale Fisheries*. Rome: FAO.

FAO. 2011. *Fishery Value Chain Analysis in Cambodia*. Rome: FAO, 33.

FAO. 2009. *The Sunken Billions: The Economic Justification for Fisheries Reform*. ISBN: 978-0-8213-7790-1.

FAO. 1997. *Review of the State of World Fisheries and Aquaculture*. Rome: FAO.

FAO. 1999. Indicators for sustainable development of marine capture fisheries. *FAO Technical Guidelines for Responsible Fisheries. No. 8*. Rome, FAO. 68 pp.

FAO. 1989. *Sustainable development and natural resources management. Twenty-fifth Conference.* C 89/2 – Suppl. 2. August. Rome, FAO. 54 pp.

Fortes, Miguel D., Jillian Lean Sim Ooi, Yi Mei Tan, Anchana Prathep, Japar Sidik Bujang and Siti Maryam Yaakub. 2018. "Seagrass in Southeast Asia: a review of status and knowledge gaps, and a road map for conservation," *Botanica Marina*. (De Gruyter, 29 May 2018). Downloaded from: https://doi.org/10.1515/bot-2018-0008

Fourqurean, J. W., Duarte, C. M., Kennedy, H., Marbà, N., Holmer, M., Mateo, M. A., et al. (2012). Seagrass ecosystems as a globally significant carbon stock. *Nat. Geosci*. 5, 505–509. doi: 10.1002/eap.1489.

Gallagher, Eileen. 2018. Building Climate Resilience in Southeast Asia: Handbook for Action. BSR. Downloaded from https://www.bsr.org/en/our-insights/report-view/climate-change-southeast-asia-building-resilience.

Gao, Chunjuan; Yanan Zhang, Dan Wu, Laibo Ma, Yushan Zhang, Qi Zhang and Xiping Huang. 2019. Development Status and Prospects of Deep Seawater Comprehensive Utilization Industry. IOP Conference Series Earth and Environmental Science 384 012030 (November 2019) DOI:10.1088/1755-1315/384/1/012030

Geyer, Roland, Jambeck, Jenna R. and Law, Kara Lavender. 2017. "Production, use, and fate of all plastics ever made", *Science Advances*, vol. 3, No. 7 (July 2017). Available at https://advances.sciencemag.org/content/3/7/e1700782.full.

Giesen, W. *et al*. 2007. Mangrove Guidebook for Southeast Asia. FAO and Wetlands International, 2006. ISBN: 974-7946-85-8

Giri, C., Ochieng, E., Tieszen, L.L. and others. 2011. Global distribution of mangroves. A product of US Geological Survey, in collaboration with ARSC Research and Technology Solutions, UNEP, NASA and the University of Queensland. Cambridge (UK): UNEP World Conservation Monitoring Centre. http://data.unep-wcmc.org/datasets/21

Global Coral Reef Monitoring Network (GCRMN) - International Coral Reef Initiative (ICRI). 2021. Executive Summary: Status of the World's Coral Reefs, 2020.

Global Environment Facility (GEF). 2016. GEF International Waters: Learning Exchange and Resources Network. July 2016.

Gordon, Arnold L. Indonesian Seas. (Accessed from: https://www.ldeo.columbia.edu/research/ocean-climate-physics/indonesian-seas).

Gössling, S. (2009). Carbon neutral destinations: a conceptual analysis. J. *Sustain. Tour*. 17, 17–37.

Griffiths, James. 2019. "The global internet is powered by vast undersea cables. But they're vulnerable". *CNN*. (Retrieved 16 April 2021.)

Green Port. 2017. Are sustainable development goals relevant for sea ports? https://www.greenport.com/news101/current-issue/apmt/are-sustainable-development-goals-relevant-for-sea-ports

Green Port. 2017. Jurong Pursues Alternative Energy Research (1 November 2017). https://www.greenport.com/news101/asia/jurong-pursues-alternative-energy-research

Green Port. 2017. Green Discounts Scheme Expands To China (7 August 2017). https://www.greenport.com/news101/asia/green-discounts-scheme-expands-to-china

Griscom, B. *et al*. 2017. "Natural Climate Solutions." In *Proceedings of the National Academy of Sciences*. October 31, 2017, 114 (44) 11645-11650.

Gullström, M., Lyimo, L. D., Dahl, M., Samuelsson, G. S., Eggertsen, M., Anderberg, E., *et al*. 2018. Blue carbon storage in tropical seagrass meadows relates to carbonate stock dynamics, plant–sediment processes, and landscape context: insights from the Western Indian Ocean. *Ecosystems* 21, 551–566.

Halpern, B., Frazier, M., Potapenko, J. *et al*. Spatial and temporal changes in cumulative human impacts on the world's ocean. *Nature Communications* 6, 7615 (2015). https://doi.org/10.1038/ncomms8615

Halpern B.S., Longo C., Hardy D. *et al*. 2012. An index to assess the health and benefits of the global ocean. *Nature* 488: 615-620.

Harper, S., Zeller, D., Hauzer, M., Pauly, D., and Sumaila, U. 2013. "Women and fisheries: contribution to food security and local economies," *Marine Policy* 39, 56–63. doi: 10.1016/j.marpol.2012.10.018

Hassellöv, I. M., Turner, D. R., Lauer, A. & Corbett, J. J. 2013. "Shipping contributes to ocean acidification," *Geophysical Research Letters*, 40: 2731–2736.

Hellenic Shipping News. 2021. "Advanced green ship technology becomes winning strategy for Korean shipbuilders" (1 June 2021). https://www.hellenicshippingnews.com/advanced-green-ship-technology-becomes-winning-strategy-for-korean-shipbuilders/

Herrera-Silveira, Jorge A., Monica A. Pech-Cardenas, Sara M. Morales-Ojeda, and Siuling Cinco.2020. "Blue Carbon in Mexico: Stocks, sequestration, and emissions at country, regional, and local spatial scales," *PeerJ* 8(8): e8790. DOI:10.7717/peerj.8790

Herrera-Silveira, Jorge A., Just Cebrian, Jennifer Hauxwell, Javier Ramirez-Ramirez, and Peter Ralph. 2009. "Evidence of negative impacts of ecological tourism on turtlegrass (Thalassia testudinum) beds in a marine protected area of the Mexican Caribbean," *Aquatic Ecology*.

Heyward, A., E. Pinceratto and L. Smith. 1997. Big Bank Shoals of the Timor Sea. An Environmental Resource Atlas. BHP Petroleum. 115 pp.

Hiroyuki Nakahara. 2009. "Economic Contribution of Marine Sector to Japanese Economy" PowerPoint presentation at the EAS Congress 2009, Manila, 23 November 2009.

Hoekstra, J. M. et al. 2010. The atlas of global conservation: changes, challenges, and opportunities to make a difference. Ed. J. L. Molnar. Berkeley: University of California Press.

Hoegh-Guldberg, Ove, Elvira S. Poloczanska, William Skirving, and Sophie Dove. 2017. "Coral Reef Ecosystems under Climate Change and Ocean Acidification," Frontiers in Marine Science (29 May 2017). Downloaded from: https://doi.org/10.3389/fmars.2017.00158

Hutahaean, Andreas, *et al*. 2015. *Blue Carbon for Blue Economy: Managing the Blue Carbon Ecosystem for Sustainable Coastal Livelihood in Indonesia*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

International Energy Agency. 2021. Global Energy Review 2021. https://iea.blob.core.windows.net/assets/d0031107-401d-4a2f-a48b-9eed19457335/GlobalEnergyReview2021.pdf

International Renewable Energy Agency (IRENA). 2018. Renewable Energy Market Analysis: Southeast Asia.

IUCN-World Commission on Protected Areas 2021. OECMs. (https://www.iucn.org/commissions/world-commission-protected-areas/our-work/oecms)

ITOPF. 2021. Oil Tanker Spill Statistics 2020. (https://www.itopf.org/knowledge-resources/data-statistics/statistics/)

Jarayabhand, Padermsak, S. Jarayabhand, C. Chotiyaputta, and S. Praisankul. 2009. *Contribution of the marine sector to Thailand's national economy.* Paper presented at the East Asian Seas Congress 2009. Manila, Philippines, Nov. 2009.

Jones, Edward, Manzoor Qadir, Michelle T.H. van Vliet, Vladimir Smakhtin, and Seong-mu Kang. 2019. "The state of desalination and brine production: A global outlook," *Science of the Total Environment* 657 (2019): 1343–1356.

Kaur, Cheryl Rita. 2015. *Contribution of the maritime industry to Malaysia's economy: Review of past and ongoing efforts*. Presentation in the Inception Workshop on Blue Economy Assessment, Manila, 28-30 July 2015.

Kaur, Cheryl Rita. 2015. *Investment Opportunities: Green Ports and Shipping*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Kobayashi, M., Watanabe A., Furukawa, K. and Sunami, A. 2018. "Innovation for Promoting Blue Economy. Empirical lessons and future perspectives." Sasakawa Peace Foundation. The Ocean Policy Research Institute.

Kojima Kiyoshi. 2000. "The "flying geese" model of Asian economic development: origin, theoretical extensions, and regional policy implications," *Journal of Asian Economics*, vol 11, issue 4, Autumn 2000, Pages 375-401. https://doi.org/10.1016/S1049-0078(00)00067-1

Laffoley, D. and Grimsditch, G. (eds). 2009. The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. 53 pp.

Lange, Glenn-Marie; Wodon, Q., and Carey, K. 2018. The Lavery, P. S., Mateo, M. Á, Serrano, O., and Rozaimi, M. 2013. Variability in the carbon storage of seagrass habitats and its implications for global estimates of blue carbon ecosystem service. *PloS One* 8:e73748. doi: 10.1371/journal.pone.0073748.

Lee Kwang Soo. 2015. *Outlook for Ocean Energy Development in Korea*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Lewis, A., S. Estefen, J. Huckerby, W. Musial, T. Pontes, J. Torres-Martinez. 2011. Ocean Energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation by O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schölmer, C. von Stechow (eds), Cambridge University Press, Cambridge, UK and New York, USA.

Long, Paul F., Bernie Degnan and Pabulo H. Rampelotto (Eds.). 2015. Advances and New Perspectives in Marine Biotechnology Volume 2: Marine Microbes & Metagenomes. Marine Drugs (available at: http://www.mdpi.com/journal/marinedrugs/special_issues/marine-biotechnology).

Losada, I.J., M. Beck, P. Menéndez, A. Espejo, S. Torres, P. Díaz-Simal, F. Fernández, S. Abad, N. Ripoll, J. García, S. Narayan, D. Trespalacios. 2017. *Valuation of the Coastal Protection Services of Mangroves in the Philippines*. World Bank, Washington, DC.

Mairizal, Aulia Qisthi; Agung Yoga Sembada, Kwong Ming Tse, and Muhammad Akbar Rhamdhani. 2021. "Electronic waste generation, economic values, distribution map, and possible recycling system in Indonesia," *Journal of Cleaner Production*, Vol. 293, 15 April 2021, 126096.

Mangahas, Maria. 2008. "Making the Vanua: Collective Fishing Technology in Batanes and an Austronesian Archetype of Society," *Philippine Studies*, 56 (4):379-412.

Mann Borgese, Elisabeth. 1986 *The Future of the Oceans: A Report to the Club of Rome* (Montreal: Harvest House).

Maritime Logistics Professional Network. 2020. Japan's Maritime Industry Powers Forward on "Green" Ships. (10 December 2020). https://www.maritimeprofessional.com/news/japan-maritime-industry-powers-forward-363741

Matsuda, Osamu. "Community-based Seagrass Bed Restoration and Management in Seto Inland Sea, Japan: Case of Akou Coast in Japan."

Matsuda Osamu. 2010. *Satoumi: The Link Between Humans and the Sea*. Our World, United Nations University. https://ourworld.unu.edu/en/satoumi-the-link-between-humans-and-the-sea.

Mavukkandy, Musthafa O., Chahd M. Chabib, Ibrahim Mustafa, Amal Al Ghaferi, and Faisal Al Marzooqi. 2019. "Brine management in desalination industry: From waste to resources generation," *Desalination*, vol. 472.

Mazarrasa, I., Samper-Villarreal, J., Serrano, O., Lavery, P. S., Lovelock, C. E., Marbà, N., *et al*. 2018. Habitat characteristics provide insights of carbon storage in seagrass meadows. *Mar. Pollut. Bull.* 134, 106–117. doi: 10.1016/j.marpolbul.2018.01.059

McIlgorm, A., H. F. Campbell, M. J. Rule. 2011. The economic cost and control of marine debris damage in the Asia-Pacific region. *Ocean Coast. Management* 54: 643–651.

Mcleod, Elizabeth, Gail L Chmura, Steven Bouillon, Rodney Salm, Mats Björk, Carlos M. Duarte, Catherine E. Lovelock, William H. Schlesinger, and Brian R. Silliman. 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering $C0_2$. *Frontiers in Ecology and the Environment*, 9(10): 552-560. DOI: https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1890/110004

McKenzie, Len J. and Rudi L.Yoshida. 2009. Seagrass Watch: Proceedings of a Workshop for Monitoring Seagrass Habitats in Indonesia. The Nature Conservancy, Coral Triangle Center, Sanur, Bali. Downloaded http://www.seagrasswatch.org/Training/proceedings/Seagrass_Watch_Bali_workshop_May09.pdf.

Meijer, L.J.J., 2021. More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. *Science Advances* (ISSN 2375-2548)

Menez, Ernani G., Ronald C. Philips and Hilconida P. Calumpong. 1983. Seagrasses of the Philippines. Smithsonian Institution Press. City of Washington. 40 pages

Meyers, G 1996, 'Variation of Indonesian throughflow and the El Niño - Southern Oscillation', *Journal of Geophysical Research*, vol. 101, pp 12,255-12,263.

Ministry of Environment (Japan) and Institute for Global Environmental Strategies (IGES). 2019. Water Environment Partnership in Asia (WEPA): Third Phase Final Report.

Ministry of Oceans and Fisheries (RO Korea) and PEMSEA. 2019. National State of Oceans and Coasts 2018: Blue Economy Growth of RO Korea. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 166 p.

Murray, B. C., L. Pendleton, W. A. Jenkins, and S. Sifleet. 2011. "Green Payments for Blue Carbon Economic Incentives for Protecting Threatened Coastal Habitats." Durham, North Carolina USA.

Murray, Nicholas J.; Clemens, Robert S.; Phinn, Stuart R.; Possingham, Hugh P.; Fuller, Richard A. (2014). "Tracking the rapid loss of tidal wetlands in the Yellow Sea" (PDF). *Frontiers in Ecology and the Environment*. 12 (5): 267–72. doi:10.1890/130260

Mustonen, Tero. 2019. "Diving Deeper with Indigenous Knowledge: Oceans & Original Peoples," *Journal of Ocean Technology*, Vol. 14, No. 1.

National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management. 2019. "NOAA Report on the U.S. Ocean and Great Lakes Economy. Charleston, S.C.: NOAA Office for Coastal Management. Available at http://coast.noaa.gov/digitialcoast/training/econreport.html.

National Parks Board (Singapore) and PEMSEA. 2019. National State of Oceans and Coasts 2018: Blue Economy Growth of Singapore. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 214 p.

Nelleman, C., E. Corcoran, C.M. Duarte, L. Valdés, C, De Young, L. Fonseca, G. Grimsditch (eds.) 2009. *Blue Carbon*: *A Rapid Response Assessment*. United Nations Environment Programme and GRID-Arendal. Norway.

Nguyen Hoang Ha. 2015. *Viet Nam's marine industries: Current state and perspectives*. PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

North, Douglass. 1990. *Institutions, Institutional Change, and Economic Performance*. Cambridge Press.

Ocean Energy Systems (OES). 2016 Annual Report.

OES. 2014. Annual Report: Implementing Agreement on Ocean Energy Systems.

Orapan Nabangchang and Nawarat Krairapanond. 2015. *Thailand Investment Opportunities in Ecotourism*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Organisation for Economic Co-operation and Development (OECD). 2021. Effective Carbon Rates 2021. https://www.oecd.org/tax/tax-policy/effective-carbon-rates-2021-brochure.pdf

OECD. 2021. Exchange rates (indicator). doi: 10.1787/037ed317-en

OECD. 2020. *Reframing Financing and Investment for a Sustainable Ocean Economy*. OECD Environment Policy Paper no. 22.

OECD. 2020a. *Economic Outlook for Southeast Asia, China, and India 2020: Rethinking Education for the Digital Era*. (https://www.oecd.org/dev/asia-pacific/SAEO2020_Overview_WEB.pdf)

OECD. 2019a. *Ocean shipping and shipbuilding*. (https://www.oecd.org/ocean/topics/ocean-shipping/)

OECD. 2019b. *Rethinking Innovation for a Sustainable Ocean Economy*, OECD Publishing, Paris. https://doi.org/10.1787/9789264311053-e

OECD. 2016. Peer Review of the Japanese Shipbuilding Industry. OECD Publishing, Paris.

OECD. 2016. *The Ocean Economy in 2030*. OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en

Österblom, Henrik, Beatrice I. Crona, Carl Folke, Magnus Nyström and Max Troell. 2017. "Marine ecosystem science on an intertwined planet". *Ecosystems*, 19 (1): 1–8.

Park, Kyunghee and Clenfield, Jason. 2019.Seven Ways the Ocean Cargo Industry Is Pursuing Green Shipping. Bloomberg News (18 January 2019). https://www.ttnews.com/articles/seven-ways-ocean-cargo-industry-pursuing-green-shipping

Parker, R.W.R., Blanchard, J.L., Gardner, C. *et al*. 2018. "Fuel use and greenhouse gas emissions of world fisheries," *Nature Climate Change*, vol 8: 333–337. https://doi.org/10.1038/s41558-018-0117-x

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) and Ministry of Environment (Cambodia). 2019. National State of Oceans and Coasts 2018: Blue Economy Growth of Cambodia. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 169 p.

Patricio, J., M. Elliott, K. Mazik, K. Papadopoulou, and C.J. Smith. 2016. "DPSIR—Two Decades of Trying to Develop a Unifying Framework for Marine Environmental Management?," *Frontiers in Marine Science*, 14 September 2016. Accessed from: https://doi.org/10.3389/fmars.2016.00177

PEMSEA and Ministry of Environment and Forestry (MOEF Indonesia). 2020. National State of Oceans and Coasts 2018: Blue Economy Growth of Indonesia. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 440 p.

PEMSEA and Department of Environment and Natural Resources (DENR Philippines). 2020. National State of Oceans and Coasts 2018: Blue Economy Growth of the Philippines. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 376 p.

PEMSEA and Department of Marine and Coastal Resources (DMCR, Thailand). 2019. National State of Oceans and Coasts 2018: Blue Economy Growth of Thailand. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 270 p.

PEMSEA and Ministry of Agriculture and Fisheries (Timor-Leste). 2019. National State of Oceans and Coasts 2018: Blue Economy Growth of Timor-Leste. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 155 p.

PEMSEA, Viet Nam Administration for Seas and Islands (VASI) and Ministry of Environment and Natural Resources (MONRE). 2021. National State of Oceans and Coasts 2020: Blue Economy Growth of Viet Nam. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 232 p.

PEMSEA and WCPFC. 2018. Report on Sustainable Tuna Fisheries for Blue Economy. UNDP-GEF Project: Sustainable Management of Highly Migratory Fish Stocks in the West Pacific and East Asian Seas. Global Environment Facility/United Nations Development Programme/ Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines.

PEMSEA. 2018b. National State of Oceans and Coasts 2018: Blue Economy Growth of China. (Unpublished report).

PEMSEA. 2018c. National State of Oceans and Coasts 2018: Blue Economy Growth of Malaysia. (Unpublished report).

PEMSEA. 2017. Proceedings of the Regional Blue Economy forum 2017.

PEMSEA. 2015. *Workshop Report: Blue Economy Development*. East Asian Seas Congress 2015.

PEMSEA. 2006. "A Perspective on the Environmental and Socioeconomic Benefits and Costs of ICM: The Case of Xiamen, PR China." PEMSEA Technical Report No. 17. Quezon City, Philippines: GEF/UNDP/IMO PEMSEA.

Philippine Statistics Authority (PSA). National income and employment data. 2015-2020.

Pomeroy, R., Nguyen, K., and Thong, H. (2009). Small-scale marine fisheries policy in Viet Nam. *Mar. Policy* 33, 419–428. doi: 10.1016/j.marpol.2008.10.001

Port Economics, Management and Policy. 2020. "*Shipping Lanes and Strategic Passages in Pacific Asia.*" Copyright © 2020-22, Dr. Theo Notteboom, Dr. Athanasios Pallis and Dr. Jean-Paul Rodrigue. https://porteconomicsmanagement.org/pemp/contents/part1/interoceanic-passages/shipping-lanes-strategic-passages-pacific-asia/

Prag, Andrew and Shanda Moorghen. 2020. "The case for sustainable ocean finance." OECD Environment Focus.

Prakash, Amir. 2018. "Boiling Point. The Impact of Climate Change in Southeast Asia," IMF Finance and Development. (https://www.imf.org/external/pubs/ft/fandd/2018/09/pdf/southeast-asia-climate-change-and-greenhouse-gas-emissions-prakash.pdf)

Raitzer, David A., Francesco Bosello, Massimo Tavoni, Carlo Orecchia, Giacomo Marangoni, and Jindra Nuella G. Samson. 2015. Southeast Asia and the Economics of Global Climate Stabilization. Mandaluyong City: Asian Development Bank (ADB).

Recide, R. 2015. *Ocean in the National Income Accounts: Philippines*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Rhamdhani, Muhammad Akbar. 2021. "Indonesia can earn US$14 billion from old mobile phones and other e-waste in 2040," The Conversation (2 March 2021).

Richards, Daniel R. and Friess, Daniel A. 2015. Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. PNAS, vol. 13 (2): 344-349. www.pnas.org/cgi/doi/10.1073/pnas.1510272113

Rotter, A. *et al*. 2020. "A New Network for the Advancement of Marine Biotechnology in Europe and Beyond," *Frontiers in Marine Science*, 12 May 2020. https://doi.org/10.3389/fmars.2020.00278

Saemangeum and the Saemangeum Shorebird Monitoring Program (SSMP) 2006–2008, Birds Korea.

Salim, Zamroni, Nika Pranata, and Fina Astriana. 2017. "Maritime Logistics Sector in ASEAN: Exploring Opportunities and Addressing Key Challenges, "ASEAN Briefs, vol. 3. Special Volume.

Sanderman, Jonathan, Hengl, T., Fiske, G., Solvik, K., Adame, M. F., Benson, L., … & Duncan, C. 2018. "A global map of mangrove forest soil carbon at 30 m spatial resolution," *Environmental Research Letters* 13 (2018). Downloaded from: https://iopscience.iop.org/article/10.1088/1748-9326/aabe1c/pdf

Savov, Vlad. 2021. "Google and Facebook's New Cable to Link Japan and Southeast Asia". *Bloomberg*. 16 August 2021.

Schwartz, Maurice L. 2005. *Encyclopedia of coastal science*, ISBN 1-4020-1903-3, p. 60.

Sea Around Us. 2007. Indonesian Sea: LME#38. In: A Global Database on Marine Fisheries and Ecosystems. Fisheries Centre, University of British Columbia, Vancouver, Canada. http://www.seaaroundus.org/lme/SummaryInfo.aspx?LME=38

SeafoodSource. 2017. Viet Nam cashing in with tuna exports in 2017. www.seafoodsource.com

Seafood Trade Intelligence Portal. 2018. Country profiles. https://seafood-tip.com

Serrano, O., Lavery, P. S., Duarte, C. M., Kendrick, G. A., Calafat, A., York, P. H., *et al*. 2016. Can mud (silt and clay) concentration be used to predict soil organic carbon content within seagrass ecosystems? *Biogeosciences* 13, 4915–4926.

Serrano, O., Lavery, P. S., Rozaimi, M., and Mateo, M. Á. 2014. Influence of water depth on the carbon sequestration capacity of seagrasses. *Glob. Biogeochem. Cycles* 28, 950–961.

Sherman, K. 2019. "Large marine ecosystems," in J. K. Cochran, J. H. Bokuniewicz, and P. L. Yager (eds), *Encyclopaedia of Ocean Sciences*, 3rd Edition, pp. 709–723. The Netherlands: Elsevier.

Sherman, K. 2018. "Large Marine Ecosystems: Their Status and Role in Ocean Governance," *Ocean Sciences.* DOI: 10.1163/9789004380271_037

Sherman, K. 2005. "A modular strategy for recovery and management of biomass yields in large marine ecosystems," in E. Levner, I. Linkov, and J.-M. Proth (eds). *Strategic Management of Marine Ecosystems*. The Netherlands: Springer. doi: 10.1007/1-4020-3198-x_4

Shi-Jun, Y. and C. Ji-yu. 1995. "Coastal salt marshes and mangrove swamps in China.

Ship Technology. 2021. "South Korea to build testbed for green vessels." (29 April 2021). https://www.ship-technology.com/news/south-korea-build-testbed/

Short, Frederick T. and Sandy Wyllie-Echeverria. 1995. "Natural and Human-induced Disturbance of Seagrass," *Environmental Conservation* 23 (1): 17-27. Downloaded from: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.466.8302&rep=rep1&type=pdf

Shunichi Honda, Deepali Sinha Khetriwal & Ruediger Kuehr (2016), Regional E-waste Monitor: East and Southeast Asia, United Nations University ViE – SCYCLE, Bonn, Germany.

Silver, Jennifer J., Noella J. Gray, Lisa M. Campbell, Luke W. Fairbanks, and Rebecca L. Gruby. 2015. "Blue Economy and Competing Discourses in International Oceans Governance," *Journal of Environment and Development*, 0(0) 1–26. DOI: 10.1177/1070496515580797

Siriraksophon, S. 2017. Sustainable management of neritic tunas in Southeast Asia: Longtail tuna and kawakawa in focus. Southeast Asian Fisheries Development Center (SEAFDEC). Downloaded from: http://repository.seafdec.org/bitstream/handle/20.500.12066/1196/sp15-2%20sustainable%20management%20of%20neritic%20tunas.pdf?isAllowed=y&sequence=1

Smith, T. W. P. *et al.* 2014. *Third IMO GHG Study 2014*. International Maritime Organization, London, UK.

Smith, S. V. 1981. Marine macrophytes as a global carbon sink. *Science* 211: 838–840.

Sofiev, M., Winebrake, J.J., Johansson, L. *et al*. 2018. "Cleaner fuels for ships provide public health benefits with climate tradeoffs," Nature Communications 9, 406 (2018). https://doi.org/10.1038/s41467-017-02774-9

Sotelo, Tiffany Joan, Hiroyasu Satoh, Takashi Mino. "Assessing Wastewater Management in the Developing Countries of Southeast Asia: Underlining Flexibility in Appropriateness," *Journal of Water and Environment Technology*, vol 17, No.5: 287–301. doi: 10.2965/jwet.19-006

Southeast Asian Fisheries Development Center (SEAFDEC). 2017. Country Profile: Philippines. http://www.seafdec.org/fisheries-country-profile-philippines, 2017

Southerland, Dan. 2020. "SE Asia slowly but surely sinking into the sea," Asia Times (8 January 2020). https://asiatimes.com/2020/01/se-asia-slowly-but-surely-sinking-into-the-sea/

Spalding, M.D.; Brumbaugh, R.D.; and Landis, E. 2016. *Atlas of Ocean Wealth*. The Nature Conservancy. Arlington, VA.

Spalding, M. D., M. Kainuma and L. Collins. 2010. *World Atlas of Mangroves*. Earthscan, London, 282 pp.

Suehisa, Masaki. 2015. Challenges and Targets of Southeast Asian Water Environment - Insights from WEPA Activities. Water Environment Partnership for Asia (WEPA).

Sumaila, U.R., M. Walsh, K. Hoareau, A. Cox, *et al.* 2020. *Ocean Finance: Financing the Transition to a Sustainable Ocean Economy*. Washington, DC: World Resources Institute. www.oceanpanel.org/bluepapers/ocean-finance-financing-transition-sustainable-ocean-economy.

Talento, R., M. Pascasio, P. Bautista, J. L. Poquiz. 2015. *The Ocean Economy in the System of National Accounts (SNA): The Philippine Case. Journal of Ocean and Coastal Economics*, Vol. 2, February 2016. Paper presented at the Symposium on Ocean in the National Income Accounts. Monterey, 25-29 October 2015.

TEEB. 2010. *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB*.

Technology Executive Committee (TEC). 2019. Updated evaluation of the Poznan strategic programme on technology transfer. Report to UNFCCC

Teh, Lydia C.L. and Pauly, Daniel. 2017. "Who Brings in the Fish? The Relative Contribution of Small-Scale and Industrial Fisheries to Food Security in Southeast Asia." *Frontiers in Marine Science* 5:44. doi: 10.3389/fmars.2018.00044

Teh, L. C. L., and Sumaila, U. R. 2013. Contribution of marine fisheries to worldwide employment. *Fish Fish*.14, 77–88. doi: 10.1111/j.1467-2979.2011.00450.x

TeleGeography. Submarine Cable Map. https://www.submarinecablemap.com/

Tilley, A., A. Burgos, A. Duarte, J. dos Reis Lopes, H. Eriksson, and D. Mills. 2020. "Contribution of women's fisheries substantial, but overlooked, in Timor-Leste," *Ambio* 2021, 50:113–124 https://doi.org/10.1007/s13280-020-01335-7

Tomascik, T, A.J. Mah, A. Nontji and M.K. Moosa. 1997. The Ecology of the Indonesian Seas. Periplus, Singapore.

Tun, Karenne, Loke Ming Chou, Annadel Cabanban, Vo Si Tuan, Philreefs, Thamasak Yeemin, Suharsono, Kim Sour and David Lane. 2004. Status of Coral Reefs, Coral Reef Monitoring and Management in Southeast Asia, 2004. Global Coral Reef Monitoring Network. Downloaded from: http://www.reefbase.org/download/download.aspx?type=10&docid=9535.

UK Department for Environment, Food and Rural Affairs. 2007. An introductory guide to valuing ecosystem services. (www.defra.gov.uk)

United Nations. 2015. First Global Integrated Marine Assessment (also known as the "World Ocean Assessment I").

United Nations. 2010. Resumed Review Conference on the Agreement Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. New York, 24-28 May 2010.

United Nations. "Our Common Future" Chapter 12: Towards Common Action: Proposal for Institutional and Legal Change. A/42/427 Annex.

United Nations Centre for Regional Development. 2020. Executive Summary of State of Plastics Waste in Asia and the Pacific – Issues, Challenges and Circular Economic Opportunities. 10th Regional 3R and Circular Economy Forum in Asia and the Pacific (Series of Webinars)

United Nations Conference on Sustainable Development (UNCSD). 2012. 'Rio +20'. 2012. Blue Economy Concept Paper.

United Nations Conference on Trade and Development (UNCTAD). 2020. Review of Maritime Transport 2020: Highlights and figures on Asia and the Pacific. Press release. https://unctad.org/press-material/unctads-review-maritime-transport-2020-highlights-and-figures-asia-and-pacific

UNCTAD. 2019. Review of Maritime Transport.

UNCTAD. 2019b. Digitalization in Maritime Transport: Ensuring Opportunities for Development. Policy Brief 75.

UNCTAD. 2018. Blue Biotrade: Harnessing Marine Trade to Support Ecological Sustainability and Economic Equity.

UNCTAD. 2018b. Technology and Innovation Report 2018: Harnessing Frontier Technologies for Sustainable Development. Switzerland: United Nations.

UNCTAD. 2016. Trade and Environment Review: Fish Trade.

UNCTAD. 2014. The Ocean Economy: Opportunities and Challenges for Small Island Developing States.

United Nations Development Programme (UNDP). 2020. *Transboundary Diagnostic Analysis for the Yellow Sea Large Marine Ecosystem*. UNDP/GEF: Implementation of the Yellow Sea LME Strategic Action Programme for Adaptive Ecosystem-Based Management. New York, NY: United Nations Development Programme.

UNDP. 2017. *Large Marine Ecosystems and Sustainable Development: A review of Strategic Management Processes and Goals*. New York, NY: United Nations Development Programme.

UNDP - IH Cantabria. 2017. Multi-Ecosystem Assessment of the Flood Protection Service for the Coastal Resilience Project.

United Nations Economic and Social Commission for Asia and Pacific (UNESCAP). 2009. Statistical Yearbook for Asia and the Pacific 2009.

United Nations Educational, Scientific and Cultural Organization (UNESCO)-Intergovernmental Oceanographic Commission (IOC), Global Environment Facility (GEF), and United Nations Environment Programme (UNEP) Transboundary Waters Assessment Programme (TWAP). 2015a. *Factsheet LME 34 – Bay of Bengal*.

UNESCO-IOC/GEF/UNEP TWAP. 2015b. *Factsheet LME 36 – South China Sea*.

UNESCO-IOC/GEF/UNEP TWAP. 2015c. *Factsheet LME 37 – Sulu-Celebes Sea*. (http://onesharedocean.org/LME_37_Sulu-Celebes_Sea).

UNESCO-IOC/GEF/UNEP TWAP. 2015d. *Factsheet LME 38 - Indonesian Sea*.

UNESCO-IOC/GEF/UNEP TWAP. 2015e. *Factsheet LME 48 – Yellow Sea*.

UNESCO/IOC, GEF and UNEP TWAP. 2015f. Large Marine Ecosystem Indicators Global Maps, 2015.

UN Environment, The Prince of Wales' International Sustainability Unit (ISU), International Coral Reef Initiative (ICRI), and Trucost. 2018. The Coral Reef Economy: The business case for investment in the protection, preservation and enhancement of coral reef health. 36pp

United Nations Environment Programme (UNEP). 2021. Five things to know about desalination. (https://www.unep.org/news-and-stories/story/five-things-know-about-desalination)

UNEP. 2020. Rising tide: Mapping ocean finance for a new decade.

UNEP. 2017. Waste Management in ASEAN Countries.

UNEP. 2017b. Terminal Report: Vulnerability Assessment and Adaptation Project for Climate Change in the Coastal Zone of Cambodia Considering Livelihood Improvement and Ecosystems (VAAP).

UNEP. 2010. The Economics of Ecosystems and Biodiversity (TEEB)

UNEP/Global International Waters Assessment (GIWA). 2005a. De Vantier, L., Wilkinson, C., Souter, D., South, R., Skelton, P. and D. Lawrence. *Sulu-Celebes Sea*, GIWA Regional Assessment 56. University of Kalmar, Kalmar, Sweden.

UNEP/GIWA. 2005b. Vantier, L., Wilkinson, C., Lawrence, D., and D. Souter (eds.) Indonesian Seas, *GIWA Regional assessment* 57. University of Kalmar, Kalmar, Sweden

UNEP/GIWA. 2005c. Wilkinson, C., DeVantier, L., Talaue-McManus, L., Lawrence, D. and D. Souter. South China Sea, *GIWA Regional Assessment 54*. University of Kalmar, Kalmar, Sweden; and. 2015.

UNEP/GEF. 2005. Global International Waters Assessment (GIWA). University of Kalmar, Kalmar, Sweden.

UNEP/GEF. 2004. Seagrass in the South China Sea. UNEP/GEF/SCS Technical Publication No. 3. pp.10. Downloaded from http://www.iwlearn.net/iw-projects/unepscs/reports/SCS_Seagrass_Booklet.pdf.

UNEP-World Conservation Monitoring Centre (WCMC) and IUCN. 2017. Protected Planet: The World Database on Protected Areas (WDPA). (www.protectedplanet.net)

UNEP-WCMC. 2005. World Atlas of Seagrasses. Accessed on 15 April 2020 at http://stort.unep-wcmc.org/imaps/marine/seagrass/viewer.htm. Relief: USGS GTOPO30

UNEP (https://www.unep.org/interactive/beat-plastic-pollution/)

United Nations World Tourism Organization (UN WTO). Yearbook of Tourism Statistics, and Compendium of Tourism Statistics.

United States Energy Information Administration (EIA), Department of Energy. 2018. "More than 30% of global maritime crude oil trade moves through the South China Sea." Downloaded from: https://www.eia.gov/todayinenergy/detail.php?id=36952.

US EIA. 2017. "*The Strait of Malacca, a key oil trade chokepoint, links the Indian and Pacific Oceans.*" Downloaded from: https://www.eia.gov/todayinenergy/detail.php?id=32452

US EIA. 2017. World Oil Transit Chokepoints.

United States Environmental Protection Agency (EPA). *Decentralized Wastewater Treatment Systems: A Program Strategy*.

United States Geological Survey (USGS). Role of Reefs in Coastal Protection. https://www.usgs.gov/centers/pcmsc/science/role-reefs-coastal-protection?qt-science_center_objects=0#qt-science_center_objects

Valiela, Ivan, James McClelland, Jeniffer Hauxwell, Peter J. Behr, Douglas Hersh, and Kenneth Foreman. 1997. "Macroalgal blooms in shallow estuaries: Controls and ecophysiological and ecosystem consequences," *Limnology and Oceanography*, 42 (5, Part 2):1105-1118. Downloaded from: https://aslopubs.onlinelibrary.wiley.com/doi/pdf/10.4319/lo.1997.42.5_part_2.1105

Viens, Ashely. 2019. IMO 2020: The Big Shipping Shake-Up (https://www.visualcapitalist.com/imo-2020-the-big-shipping-shake-up/)

Virola, R., R. Talento, E. Lopez-Dee, M. R. Romaraog and F. Polistico. 2010. *Towards a Satellite Account on the Maritime Sector in the Philippine System of National Accounts: Preliminary Estimates*. Paper presented at the 11th National Convention on Statistics, Manila, 4-5 Oct 2010.

von Jouanne, A. 2019. Harvesting the Power of the Ocean. (American Society of Mechanical Engineers, 29 March 2019). https://www.asme.org/topics-resources/content/harvesting-the-power-of-the-ocean

Wang, Siyuan and Notteboom, Theo. 2013. LNG as a ship fuel: perspectives and challenges. *Port Technology*, 60:15-17. https://wpassets.porttechnology.org/wp-content/uploads/2019/05/25182129/LNG_LR.pdf

Ward, A. 2012. Abstract and Presentation for the East Asian Seas Congress 2012, Subtheme 1, Workshop 1. Changwon, RO Korea. 2012.

Wealth Accounting and the Valuation of Ecosystem Services (WAVES). 2017. Valuing the Protection Services of Mangroves in the Philippines. Washington, DC: World Bank.

Wen Quan. 2015. *Development of Ocean Economy in China*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Westphal, Michael I.; Hughes, Gordon A.; Brömmelhörster, Jörn (eds). 2013. Economics of Climate Change in East Asia. Mandaluyong City: ADB.

Whisnant, R., Ross, S.A., 2019. Enabling Blue Economy Investment for Sustainable Development in the Seas of East Asia: Lessons on Engaging the Private Sector for Partnership and Investment. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines. 118 pp.

Williams, S. L., & Ruckelshaus, M. H. 1993. Effects of Nitrogen Availability and Herbivory on Eelgrass (Zostera Marina) and Epiphytes. *Ecology,* 74(3), 904–918. https://doi.org/10.2307/1940815

Winebrake, J. J., Corbett, J. J., Green, E. H., Lauer, A. & Eyring, V. 2009. "Mitigating the health impacts of pollution from oceangoing shipping: an assessment of low-sulfur fuel mandates," *Environmental Science and Technology*, 43: 4776–4782.

World Bank. 2021. Online data: World Development Indicators.

World Bank. 2021a. Dataset: World Development Indicators for Cambodia. https://data.worldbank.org/country/cambodia.

World Bank. 2021b. Dataset: World Development Indicators for China. https://data.worldbank.org/country/CN

World Bank. 2021c. Dataset: World Development Indicators for Indonesia. https://data.worldbank.org/country/indonesia

World Bank. 2021d. Dataset: World Development Indicators for Japan. https://data.worldbank.org/country/japan.

World Bank. 2021e. Dataset: World Development Indicators for DPR Korea. https://data.worldbank.org/country/korea-dem-peoples-rep.

World Bank. 2021f. Dataset: World Development Indicators for RO Korea. https://data.worldbank.org/country/Korea-Rep.

World Bank. 2021g. Dataset: World Development Indicators for Lao PDR. https://data.worldbank.org/country/LA.

World Bank. 2021h. Dataset: World Development Indicators for Malaysia. https://data.worldbank.org/country/MY.

World Bank. 2021i. Dataset: World Development Indicators for Philippines. https://data.worldbank.org/country/PH

World Bank. 2021j. Dataset: World Development Indicators for Singapore. https://data.worldbank.org/country/SG.

World Bank. 2021k. Dataset: World Development Indicators for Thailand. https://data.worldbank.org/country/thailand

World Bank. 2021l. Dataset: World Development Indicators for Timor-Leste. https://data.worldbank.org/country/Timor-Leste

World Bank. 2021m. Dataset: World Development Indicators for Vietnam. https://data.worldbank.org/country/Vietnam.

World Bank. 2021n. Carbon Pricing Dashboard. https://carbonpricingdashboard.worldbank.org/map_data.

World Bank. 2021o. *Market Study for the Philippines: Plastics Circularity Opportunities and Barriers*. Washington DC.

World Bank. 2021p. State and Trends of Carbon Pricing 2021. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/35620 License: CC BY 3.0 IGO.

World Bank. 2020. State and Trends of Carbon Pricing 2020. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/33809 License: CC BY 3.0 IGO.

World Bank. 2017. *The Little Green Data Book, 2017*. Washington, DC: World Bank.

World Bank. 2015. *Improving On-site Sanitation and Connections to Sewers in Southeast Asia-Insights from Indonesia and Vietnam*. https://www.wsp.org/sites/wsp/fi les/publications/WSP-Improving-On-site-Sanitation-Connections-to-Sewers-Southeast-Asia.pdf.

World Bank. 2009. *The Philippines: Country Environmental Analysis*.

World Bank. 2006. Where is the Wealth of Nations? Measuring Capital for the 21st Century. Washington, DC: The World Bank.

WorldFish. n.d. Ecosystem Services for Poverty Alleviation: Marine and Coastal Situational Analysis.

WorldFish/Tilley, A. 2016. "*Sustainable fisheries and food security in Timor-Leste.*" Powerpoint presentation at the Inception Workshop for the Development of the State of Oceans and Coasts Report of Timor-Leste, held on 1 September 2016 in Dili, Timor-Leste.

World Travel and Tourism Council (WTTC). 2017. *Travel & Tourism. Economic impact 2017: Southeast Asia*. Available at: https://www. wttc.org/-/media/files/reports/economic-impact-research/regions- 2017/southeastasia2017.pdf

WWTC. 2016. *Comparative Economic Impact: Asia-Pacific Summary*.

WWF. 2017. Coral Triangle facts. Available at: http://wwf.panda.org/what_we_do/where_we_work/coraltriangle/coraltrianglefacts.

Xu Jinzhong. 2015. *Marine Natural Product Chemistry in China and International Cooperation*. Abstract and PowerPoint presentation for the East Asian Seas Congress 2015, Da Nang, Viet Nam, 16-21 Nov 2015.

Xue, X., H. Hong and A.T. Charles. 2004. "Cumulative Environmental Impacts and Integrated Coastal Management: The Case of Xiamen, China." *Journal of Environmental Management* 71 (3): 271–83. https://doi.org/10.1016/j.jenvman.2004.03.006,

Yellow Sea Large Marine Ecosystem (2020). *YSLME Commission*. *UNDP/GEF: Implementing the Strategic Action Programme for the Yellow Sea Large Marine Ecosystem*. New York, NY: Yellow Sea Large Marine Ecosystem.

Zeldovich, Lina. 2020. High-Tech Sails Bring Wind Power to Big Ships. (American Society of Mechanical Engineers, 10 February 2020). https://www.asme.org/topics-resources/content/high-tech-sails-bring-wind-power-to-big-ships